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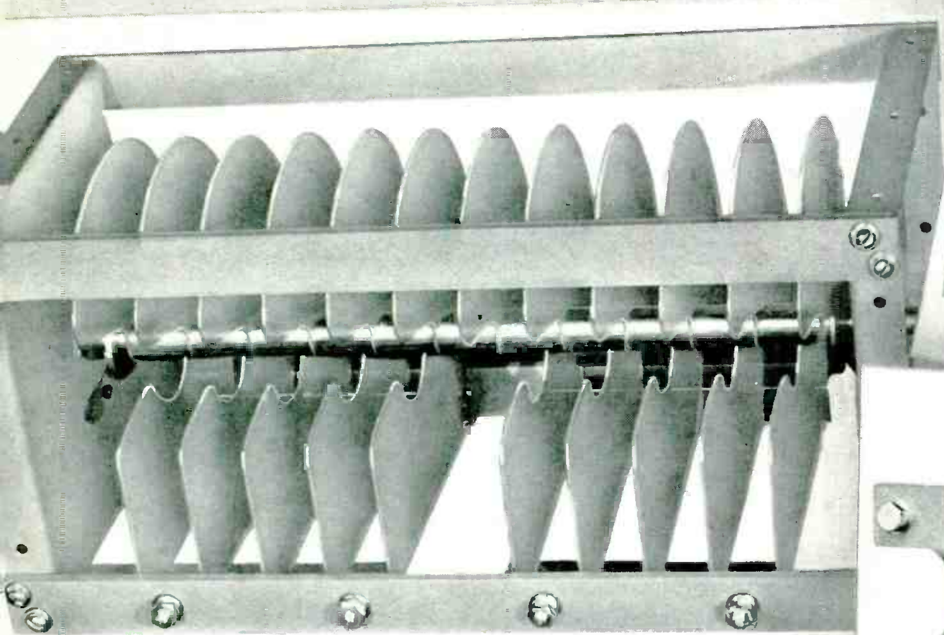
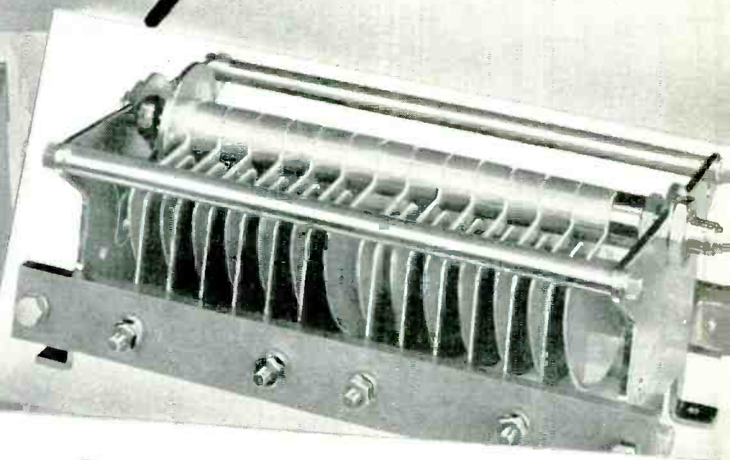
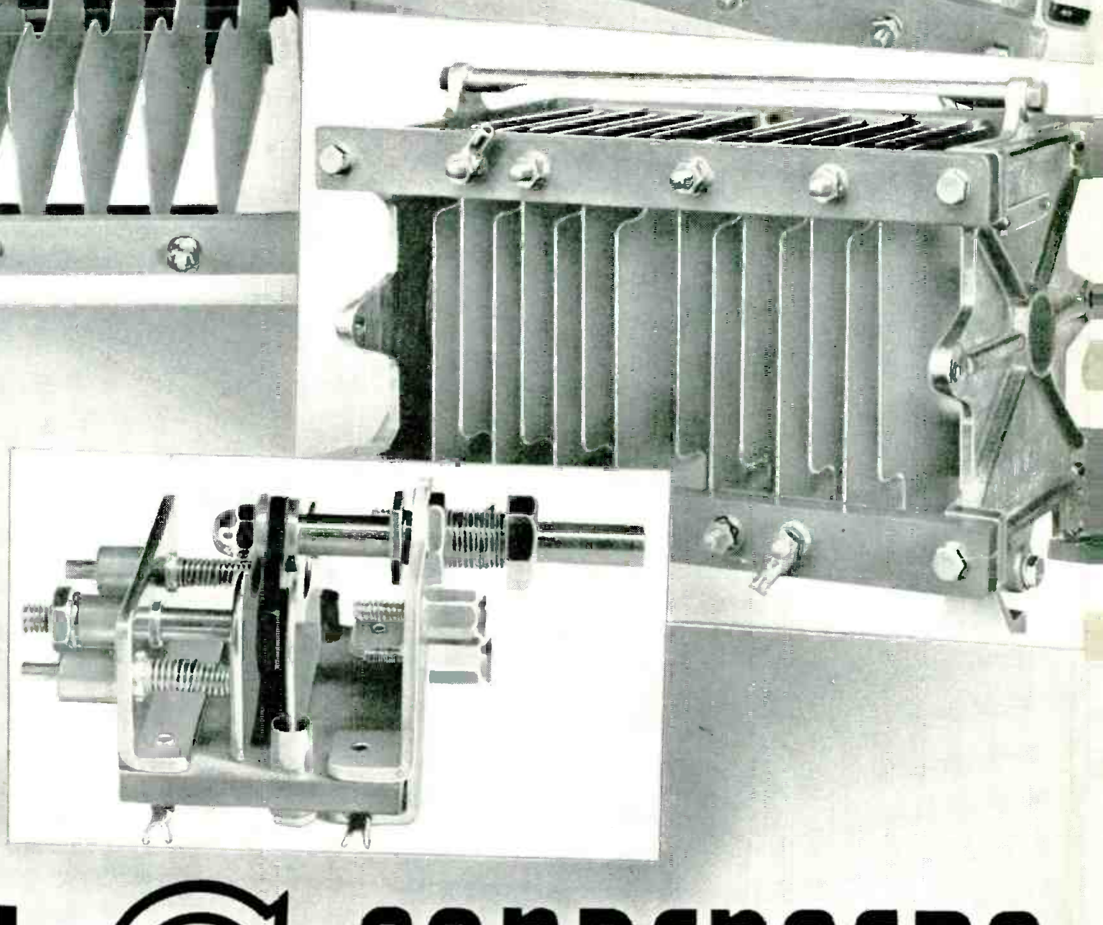
Standard of Comparison







PZ-100-QD Dual variable transmitting condenser. 9000 V. spacing. Normal airgaps to 1/2 inch.

TC-100-UD Dual variable transmitting condenser. Normal maximum airgap .294 inches. 1/2 inch airgap available in 80 mmf. single or 40 mmf. dual.

HZ-100-ZD Dual fixed transmitting condenser. 1/2 inch airgap 100 mmf. per section.

A-7220 Micro-capacitor bridge adjuster. Typical of the many special components that are produced to customer specifications.

CARDWELL CONDENSERS

Specified and used generously in practically every type of communications equipment from the lowest power transmitters to the highly complex controls of frequency checking devices, CARDWELLS have never failed to justify their selection.

THE ALLEN D. CARDWELL MANUFACTURING CORPORATION

83 PROSPECT STREET **BROOK**

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EDITORIAL

PEACE-WORK

◀ We are by necessity forced to consider the peace while involved in the war; and it is neither safe nor prudent to dispense with a long-range view because of a present urgency.

Before fall arrives, we will have reached complete war economy, which means that 50 percent or better of the national income and a considerably higher percentage of manpower and womanpower will have been diverted to the war effort. As a result of this the main line of civilian economy will fall into disuse; and at the termination of this war, it will be the task of the government, of industry and the people to get this economy rolling again in the shortest possible time.

To change the metaphor, the humpty-dumpty of civilian economy will have taken a great fall, and it will take more than all the king's horses and all the king's men to put him together again. There will be the problems of industrial over-expansion, a scattering of manpower, and the means of financing to contend with; and how best these problems can be solved we do not know.

But it may be said that the problems of the post-war period will be eased by long-range planning. The Government is thinking in terms of voluntary or compulsory saving; industry, in the midst of its war trials, of civilian product development. If a sufficient number of products having wide consumer acceptability are "on the shelf" when peace comes, and there is an accumulation of purchasing power, the switch-over from war production to civilian production can be made without a serious dislocation of our economic structure.

Naturally, new consumer products will emerge as a result of the war effort; and aborted developments, such as television, will account for large markets. But the appetite of post-war industry will be huge, and our salvation will rest in what we are prepared to feed it at the moment the last shot is fired.

Our immediate concern is to win the war, but in doing so we cannot afford to lose the peace—and peace for us has its basis in a return to a civilian economy. Hence, if we are not to be short-sighted, some time—even if it be off-time—must be devoted to the sowing of seed.

Our field holds special promise in this respect. The future is irrevocably hitched to it. Engineers, research workers, and radio amateurs in particular, have the opportunity of experimentation along old and new lines, and with the assurance that they will be practicing something more than a mere diversion.

We offer the suggestion that, as an aid to his country, each man take up the exploration of some specific subject along the path of his particular interest, whether that be radio, sound, or electronics. We, for our part, will present from time to time ideas that seem worth following through, as impractical as they may seem on the surface. The rest we'll leave to you.

ULTRA-HIGH FREQUENCY

The engineer has been put to no end of head-scratching in his search for abbreviations that would serve to differentiate between ultra-high frequency and *really* ultra-high frequency. The English have gone to the extreme of using the abbreviation "uhfi", meaning "ultra-high frequency indeed", which is not bad, but still not good.

There is no question but that "uhf" is sufficient for general consumption, but the man in the know requires a finer distinction, if for no other reason than to suggest the character and behavior of the waves to which he is referring.

Since we are in the habit of expressing the frequencies of the shorter wavelengths in terms of megacycles, why not segregate our regions mathematically? Thus, all frequencies from 10 to 100 mc could be referred to as 10hf; those from 100 to 1000 mc as 10^2hf; and those from 1000 mc upward as 10^3hf. Or, in the same sequence and segregation: dhf, hhf, and khf—d for "deka", h for "hekto" and k for "kilo".

In any event, we prefer one or the other to such handles as "ultra-ultra" or "super-dooper".

—M. L. M.

RADIO

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COVER

Corporal Sterner, U.S.A., replaces a heat coil on the vertical side of the main distributing frame in the telephone exchange at Fort Dix, New Jersey.

ARTICLES

MISCELLANEOUS

"BELL LABS"

Its Philosophy Is The Telephone

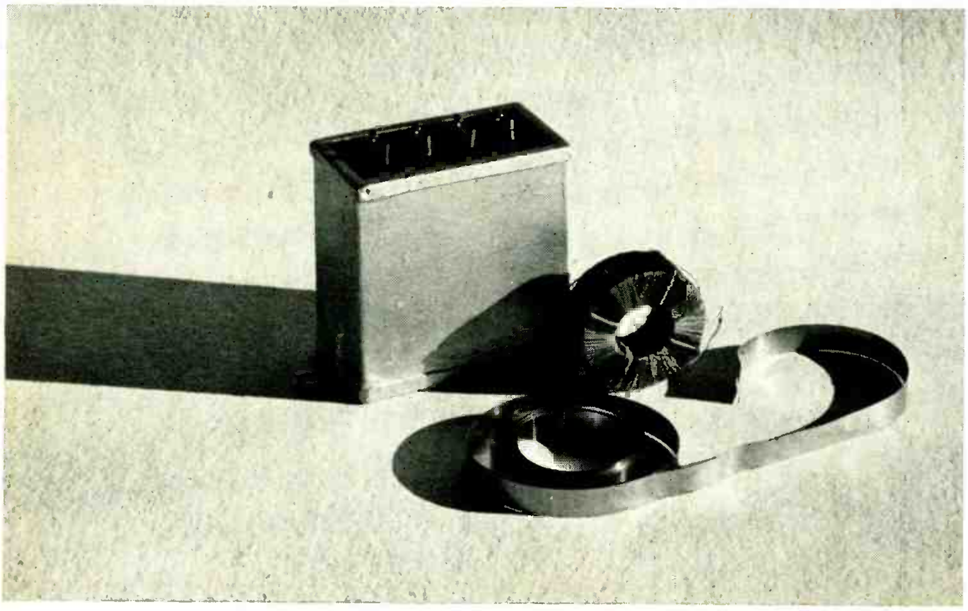
"a telephone service for the nation, so far as humanly possible free from imperfections, errors or delays, and enabling at all times anyone anywhere to pick up a telephone and talk to anyone else, clearly, quickly and at a reasonable cost."—Walter S. Gifford, President, American Telephone and Telegraph Co.

◀ Living by and for the telephone, and serving twin businesses where the incentive for maximum profits and the drive for improvement that results from active and strong competition does not exist, the Bell Telephone Laboratories should, by rights, have run into stagnation about the time the telephone became a national asset. That it flourished, instead, is a minor miracle and a problem in seeming contradictions, with the answer to be found in methods of doing things unique in the field of industrial research.

History

Before there was a telephone there was a telephone laboratory. In a corner of a Boston workshop Alexander Graham Bell carried on researches, studying speech and hearing; and devising apparatus and methods for the electrical communication

In this evacuated bell jar thin fims of various substances are deposited on metal surfaces. It is used principally in research studies of the "varistor" employed in carrier-current systems.



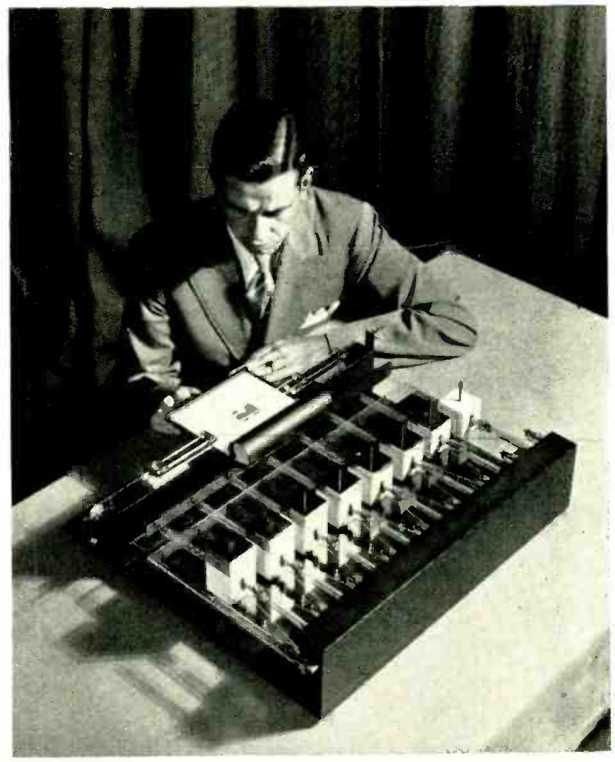
A magnetic generator of harmonics used in carrier-current telephony. The coil distorts the input wave-form so that the output is rich in harmonics.

of intelligence. Ever since that time the parent company of the Bell System, which evolved from his invention, has maintained telephone laboratories. In 1907 all the laboratories were consolidated into a unit to be operated as the Engineering Department of the Western Electric Co.

By 1925 the laboratory work had so grown in range and intensity, and in the magnitude of the personnel involved, that it could best be carried on by a corporation devoted solely to research and development.

Still, not all of the research problems of communication in which the American Telephone and Telegraph Co. was interested were of a laboratory character. In its own organization that company continued to maintain a development and research group, with responsibilities in the development and establishment of proper standards for transmission and switching. It was its duty, also, to envisage the art as a whole, to foresee needs and trends, and to bring desirable lines of development to the attention of its colleagues in the laboratory organization. In 1934 there was a further centralization and this A. T. and T. group was consolidated with the Laboratories. All of its activities are now carried on under the corporate name "Bell Telephone Laboratories, Inc."

The Laboratories has a dual responsibility: to the A. T. and T. for fundamental researches and developments; and to the Western Electric Co., as



Properties of materials are sometimes explored through mechanical analogs. This model, developed for the study of hysteresis, has been found useful in fundamental research in the theory of magnetic and microphonic action.

OPERATIONAL SETUP

F. B. JEWETT, CHAIRMAN

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Bell Telephone Laboratories, Inc.

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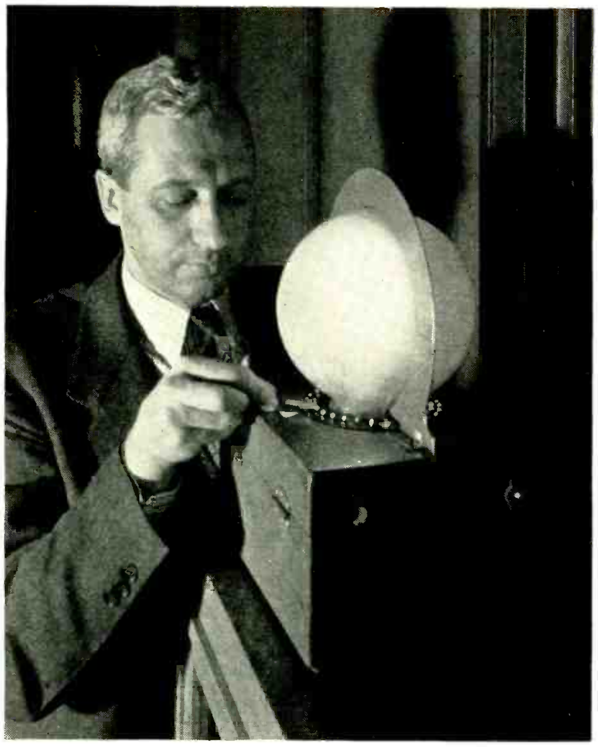
Patent Legal Financial Accounting Commercial Service Personnel Publication	Research in: Physics Optics Magnetics Acoustics Electronics Chemistry Radio Television Radio Engineering	Development and design of: Switches Networks Filters Transformers Telephone Instruments Microphones Loud Speakers Line Apparatus Inspection Methods	General Engineering Circuit Design and Testing Trial Installations Power Supply Apparatus Telegraph Engineering Central Office Equipment Transmission Engineering Protection Studies Carrier Current Systems Testing Apparatus



Marking locations of sun spots on an illuminated glass sphere. As a result of its careful study, the Laboratories has been able to anticipate periods when sun-spot activity has been especially troublesome.

the manufacturing unit of the Bell System, for the embodiment of the results of that work in designs suitable for manufacture. This relationship is reflected in the composition of the Laboratories' board of seven directors which includes three officials from each of the parent companies and the president of the Laboratories, Dr. Oliver E. Buckley. The vice president of A. T. and T., Dr. Frank B. Jewett, is chairman of the board.

The Laboratories headquarters are at 463 West St., New York. Two other sections are located at 180 Varick St. and at 250 Hudson St. At Murray Hill, New Jersey, a group of buildings has recently been completed which provide laboratories and office facilities for about 800 persons. There are several field laboratories for development studies which require either large open spaces or typical climatic conditions. The most important of these are located in New Jersey, at Deal, Holmdel, Whippany, and Chester.

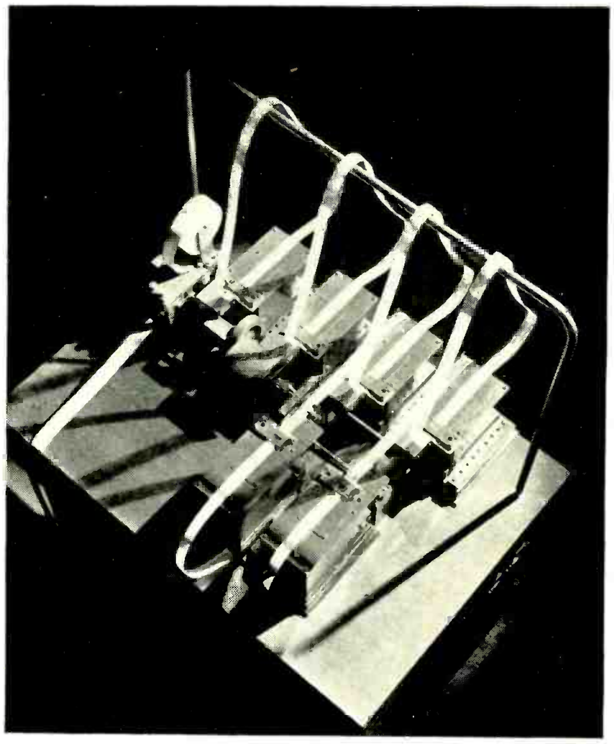
Operational Setup

Because the products of the Laboratories are ideas, inventions and designs its personnel is predominantly scientific. Of its present working force of about 5,200 over 2,000 are highly trained and experienced in science and engineering. For their work they are organized on a functional basis with regard both to the fields in which they are individually expert and to the problems which the Laboratories is attacking. They are grouped into three main technical departments, known respectively as: Research, Apparatus Development, and Systems Development (see chart of Operational Setup). Associated in the technical departments with these scientists and engineers are about 1,000 technical assistants, laboratory mechanics, supervising and designing draftsmen, secretaries and clerks.

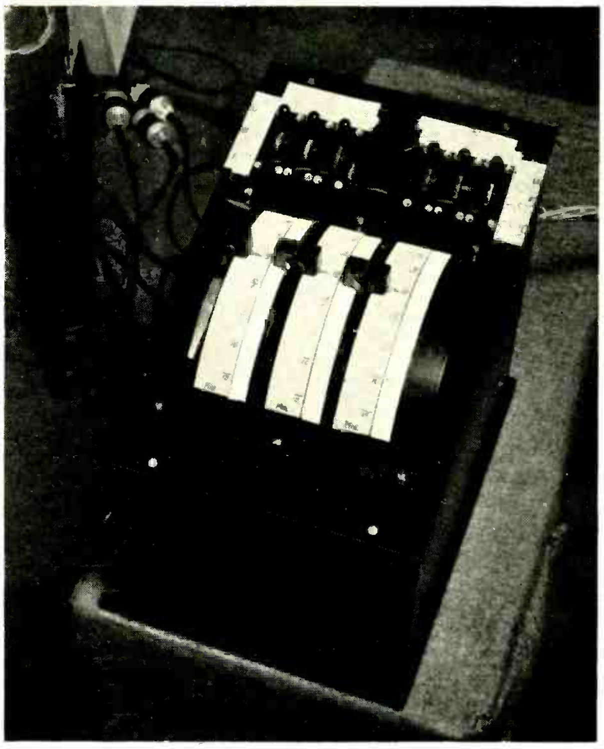
We have here the perfect coordination of the three essential aspects of industrial research—the managerial, pure science and development engineering, with management at the top.

The Research Department is organized and administered with a view to fostering the spirit of research in its individual investigators, to associating them so that individual and group experience may find its most useful expression. The research man is encouraged to proceed along paths peculiar to his talent, with, perhaps, the one reservation that what he undertakes holds promise of some economic or social significance. In fact, within limits, the management furthers his avocational desire because as regards creative ability it is recognized that the best results are obtained from men who are most happy in their daily environment. In this respect, however, care is taken so to organize the research group as to reduce to a minimum the tendency for men to proceed wholly as individuals rather than as part of a team.

The approach to research is based on the so-called scientific method which came to be accepted rather generally about 150 years ago, and altered



Tape-punching device used for "trunking probability" studies. The number of calls likely to be uncompleted because of "line busy" conditions is determined. Thus the capacity of an office is predetermined.



Control device used in "stereophonic" recording by which frequencies, amplitudes, and spatial relationships of sound can be altered to enhance the effect of the reproduction.

all preceding practice by developing and perfecting a mode of attack by which men undertake to solve problems not by theorizing and speculating about them but by theorizing to a point and then testing the theory under definitely and positively controlled conditions. In the main these experimental control tests do not have for their object the creation of new things but rather a production of sure foundations on which new things can with certainty be created.

Only a part of the researcher's equipment can be of standardized form, for few of the things he is concerned with are standardized until their engineering worth is established, and by that time, for the most part, they have left the field of research.

The Development Engineer deals with the fact and the experience within the range of his talent. In many cases the resources of one specialized field are not properly appreciated in another; but to effect the necessary coordination and interpretation in improved instruments and methods is the province of engineering as distinct from research.

Because the activities of the Laboratories are concerned with all the scientific and engineering problems of electrical communication, its technical work covers a wide range of subjects. It includes fundamental research in physics, chemistry and mathematics; the development and design of suitable apparatus for electrical communication both wire and radio; the development of complete communication systems and their design for economical and efficient operation; and the development of power equipment and other apparatus and circuits essential to the control, switching and supervision of communication circuits. The Laboratories' work covers the study of speech and hearing; the development of instruments for the transmission of intelligence; the design of apparatus and the investigation of materials for use in the construction of the telephone plant. It also covers the development of statistical methods of inspection and their adaptation for use by manufacturers and installers; and the development and classification of standards of quality for communication apparatus and systems.

Because of the diversity of projects and their relationship to more than one branch of science, the chemist interested in wood preservation for poles and crossarms becomes temporarily a biologist experimenting with fungus growths; the telephone engineer approaches the phonetician, and the radio engineer may turn meteorologist and a student of the ionized upper layers of the atmosphere. Sooner or later the workers must cross the arbitrary boundaries between chemistry and physics; between electrical engineering and mechanical engineering; between physics and biology or psychology, and sooner or later they may enter an economic interest or motive. As a result, there is an intermingling of effort that promotes teamwork.

Dr. Jewett has pointed out that this advantage has been augmented in many cases by the fact that there has been an increasing tendency to transfer

(Continued on page 54)

This small amplifier shown being tested with a cathode-ray oscillograph is used principally for monitoring the output of broadcast transmitters.

Determining the Characteristics of

AUDIO AMPLIFIERS

CORTLANDT VAN RENSSELAER*

◀ Practically all articles describing audio amplifying equipment make claims regarding maximum undistorted output, low hum level and wide frequency response. It is generally found, particularly with amplifiers employing inverse feedback, that these claims are highly exaggerated. The principal reason for this is that characteristics are often dependent upon accurate values of resistors, condensers, and transformers, and these, except in the more highly priced class, are usually not particularly exactingly constructed. So it is often expedient to make various tests in order to determine the exact characteristics of amplifiers. This is particularly important when one is to be used for recording, since in this case it is sometimes essential that certain ranges of frequency be accentuated. While accomplishing this is exceedingly difficult by ear, with simple measuring equipment it can be done quite easily.

Necessary Test Apparatus

The following apparatus is necessary for making these tests.

1. *An audio oscillator capable of covering the range of frequencies between 20 and 10,000 cycles.*
2. *A vacuum tube voltmeter which will register full scale with less than 0 db of power across a 500-ohm line.*
3. *An a-c voltmeter.*
4. *An oscilloscope. This is not needed for determining frequency characteristics, but proves valuable in distortion analyses and in locating hum.*

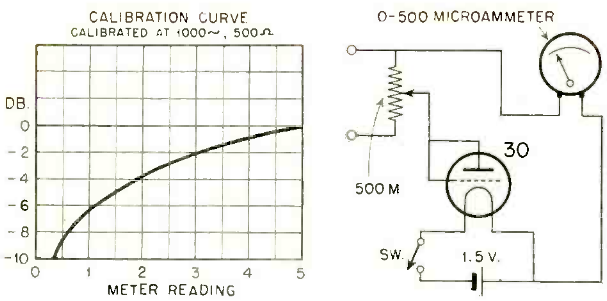


Fig. 1. Schematic of simple vacuum-tube voltmeter and, at the left, its calibration curve.

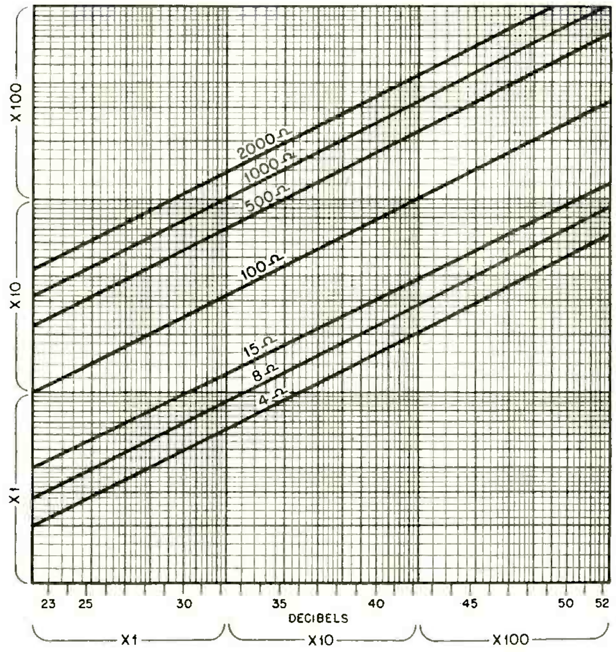


Fig. 2. A graph from which the output of an amplifier may be determined from the voltage and impedance. Its use is described in the text.

The audio oscillator need not be a particularly elaborate one. It is not necessary for the output to be constant over a large range of frequencies since the input power to the amplifier is measured and maintained constant during the tests. There are several inexpensive oscillators on the market today, and many have been described in the various radio publications.

A simple vacuum tube voltmeter for audio work with approximate full scale deflection at 0 db can be constructed easily with a type 30 tube and a 0-500 microammeter. The schematic diagram for this, and the relative calibration curve are shown in *Fig. 1.* This unit has the advantage over a copper-oxide rectifier type of drawing very little current from the line, and also of causing the meter reading to vary much less with wide changes in frequency than with the c.o.r. unit. The calibration curve shows only

*P.O. Box 829, Stanford University, California.

relative values of power. If the filament voltage is exactly 1.5 volts, full scale deflection of the meter will be close to 0 db at 500 ohms. As this voltage changes, the calibration will vary proportionally between certain limits. However, in the purposes for which it will be used here, the reading is purely relative, the actual calibration not being important.

The second audio power meter does not have to be nearly so sensitive as the first, since its purpose is to measure the output of the amplifier rather than the input. Any a-c voltmeter other than the repulsion type will serve this purpose. A convenient method for combining both meters in a single bakelite case is through the use of one of the Triplett twin instruments. A 500 microammeter movement for the sensitive meter can be secured for the left side of the case and a 5-mil movement can be placed in the right hand position. This case can be mounted on the front of a small metal box containing the 30 tube, filament battery and copper oxide rectifier for the larger meter. Thus a rather compact unit can be constructed embodying all of the essential metering facilities for testing audio characteristics.

The oscilloscope need not contain all of the features of the large laboratory types to be perfectly useful in making simple distortion and hum tests. An inexpensive one which operates with an 813 tube is described in the *"Radio Handbook."* Although this has no amplifiers or horizontal sweep circuits, it is satisfactory for most audio testing.

It is often found that a vacuum tube power amplifier will produce about fifty percent more audio power than the undistorted ratings for the tubes would cause one to conclude. Therefore it is difficult to determine by ear when the point of maximum undistorted output is reached. This is because many loudspeakers, particularly those incapable of reproducing high audio frequencies, muffle or mask distortion to the extent that it cannot be heard.

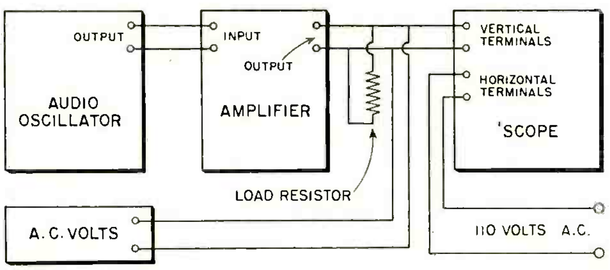


Fig. 3. Layout of equipment for making distortion tests.

An amplifier whose sole purpose is to play phonograph records, can be allowed to have as much as five percent distortion, whereas one which is to be used for recording should not be allowed to operate with more than two percent. Since many amplifiers are constructed with a view towards eventually using them for recording, it is often important that distortion measurements be made.

Measuring Output

A satisfactory means must be had for measuring the power output of the amplifier to be tested. The easiest means for doing this is through the use of an a-c. voltmeter. This must be placed across the output of the amplifier in parallel with a resistor whose value corresponds to the impedance of the output transformer secondary and whose power rating is sufficient to withstand that generated by the amplifier. The speaker which is to be used with the amplifier may of course be substituted for the resistor if none is available, but this will result in a considerable amount of noise if the unit is capable of delivering much power.

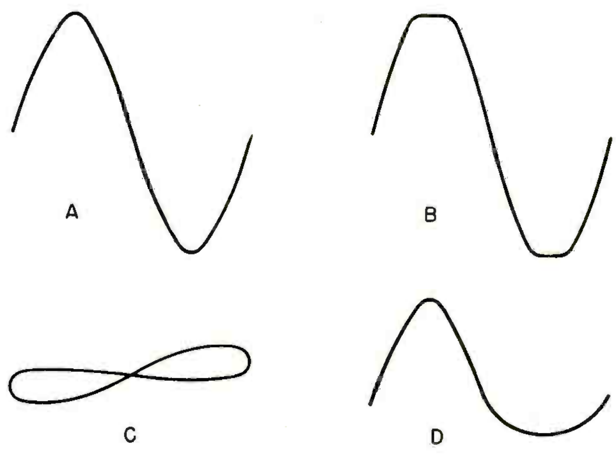


Fig. 4. Oscilloscope patterns indicating: A—proper operation; B—distortion; C—presence of resonant circuits; D—unbalance in push-pull stage.

A means for readily determining the output of the amplifier from the voltage and the impedance is through the use of the graph of *Fig. 2*. Power is expressed logarithmically along the bottom. There are three phases from 1 to 10. The first of these must be multiplied by 1, the second by 10 and the third by 100. In other words the first series of numbers go from 1 to 10 watts, the second from 10 to 100 watts and the third from 100 to 1000 watts.

A scale of decibels also appears on the bottom of the graph. Thus the output can be expressed in terms of either db or watts. The formula for converting power to decibels is

$$db = 10 \log \frac{P_1}{.006} \quad \text{where}$$

$$P = \text{Power in watts}$$

The a-c voltages are expressed logarithmically along the left side of the graph. These are to be multiplied by the same figures as are those on the power scale. The impedance across which the voltage is measured is shown on the slanting lines. To determine the power which produces a given voltage, find the voltage on the left column and where this intersects the impedance graph, **read the watts or db** on the lower scale. The formula for determining power from any impedance and voltage is

$$W = \frac{E^2}{I} \qquad \text{where}$$

W = Watts; E = Voltage; I = Impedance.

Distortion Tests

A simplified diagram for distortion tests is shown in *Fig. 3*. Several audio frequencies should be tested for distortion since the amplifier may be distorting the low frequencies whereas it is operating normally at higher ones. If the oscilloscope does not have a saw-tooth oscillator, the horizontal terminals should be connected to the 110-volt line. The image on the screen can be made stationary by varying the frequency of the audio oscillator slightly. It will be found that there is a point at every multiple of 60 cycles where the image will become stationary.

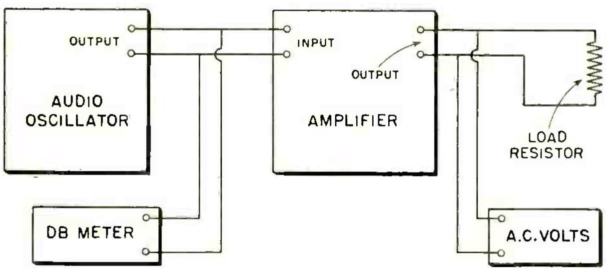


Fig. 5. Setup of equipment for frequency-response tests.

If the scope does contain a saw-tooth oscillator it is simply necessary to set the audio oscillator at the desired frequency and synchronize the 'scope with this frequency. At low output, if the amplifier is operating properly, the figure on the screen will look like that of *A* in *Fig. 4*. There may be more than one such curve on the screen, but each should be perfectly symmetrical. If the shape resembles that of *D* in *Fig. 4*, there is an unbalance in the amplifier. If it has a push-pull output stage, one of the tubes is probably not putting out as much power as the other. Any roughness or lack of symmetry in the sine wave indicates the presence of distortion. Any spurious curves indicate the presence of parasitic oscillations or motorboating.

It might be well to mention that very small percentages of distortion in the nature of one or two per cent will not usually show up on the scope unless the screen is very large.

To determine the maximum undistorted output of an amplifier, increase the input power until the tops of the sine curves begin to flatten out as at *B* of *Fig. 4*. Then reduce the power until the waveforms appear as at *A*. At this point the undistorted output will be at a maximum.

Response Characteristics

Frequency response characteristics even more than distortion are important in an analysis of the operation of an amplifier. *Fig. 5* indicates the usual set-up of equipment for making these tests. *Fig. 6*, which shows several examples of response characteristics, demonstrates the method for plotting these curves. All power computations should be made in db. These, as can be seen, are plotted along the left of the graph while frequency is indicated on the bottom.

The db meter must be quite sensitive. It should be of the vacuum-tube voltmeter type so that it will consume little of the output power of the oscillator. It is unnecessary to know the exact calibration of this meter since it is used only to maintain the input to the amplifier at a constant level. Most oscillators do not have essentially even output with wide variations in frequency. Therefore it is important that the oscillator output control be readjusted as the frequency is varied.

The best method for plotting the characteristic curve is to roughly determine the frequency at which the amplifier has maximum output by quickly testing over the frequency range. The input should then be adjusted so that the output at this particular frequency is about one-half the maximum power capability of the amplifier. Then accurate measurements should be made at 20, 30, 40, 50, 60, 80, 100, 150, 200, 300, 400, 500, 600, 800, 1000, 1500, 2000, 3000, 4000, 5000, 6000, 8000, and 10,000 cycles.

If the amplifier is to be used for playing phonograph records, it is desirable for the low frequencies to be accentuated and for the high frequencies to be attenuated as shown in curve *A* of *Fig. 6*. However, if it is to be used for recording or for other purposes where linear response is essential, the curve should be practically flat between 20 and 10,000 cycles. This condition is indicated in curve *B*. For most purposes an amplifier is considered to have good characteristics if the variation in db over the frequency range is less than 5. Humps in the curve such as those indicated at *C* are normally caused by resonant circuits in the coupling between stages. Whereas these humps are desirable in certain cases, they are as a general rule to be avoided.

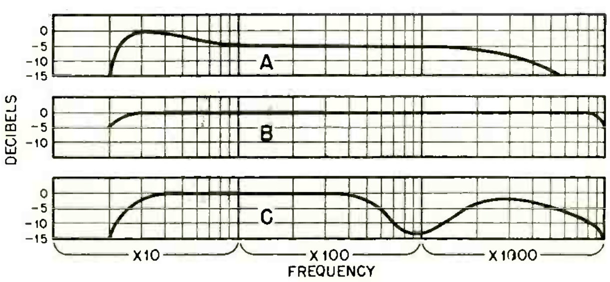


Fig. 6. Several examples of frequency response characteristics of audio amplifiers. The conditions for each are described in the text.

Hum Level and Gain

It is possible to determine how far below the power output of an amplifier the hum level rests by first measuring the output voltage caused by the hum in the amplifier, changing this to db; then measuring the output voltage from the audio signal, converting this to db and subtracting the first number from the second. It can then be said that the hum level is a certain number of db below the signal level. To be inaudible, hum must be at least 40 db lower in volume than the signal.

In order to locate the stage of an amplifier where most of the hum is originating, the unit should be connected to an oscilloscope, as shown in *Fig. 7.* If any appreciable amount of hum is present, the pattern will resemble that of *C* in *Fig. 4.* By systematically removing the tubes from the amplifier, beginning with the first stages, a change in the shape of the pattern will indicate where the hum is entering the circuit. When all of the tubes have been removed the double loop shape should become a straight line.

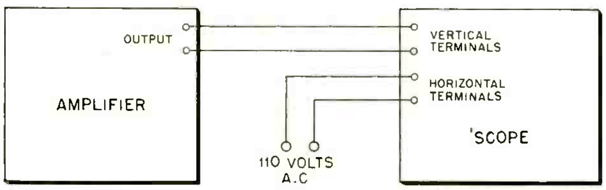


Fig. 7. Setup of equipment for conducting hum tests.

Quite often it is advisable that the overall gain of an amplifier be known. This is normally expressed in terms of db of gain. The procedure for determining gain is to measure the input to an amplifier necessary to produce maximum undistorted output. Then the formula is

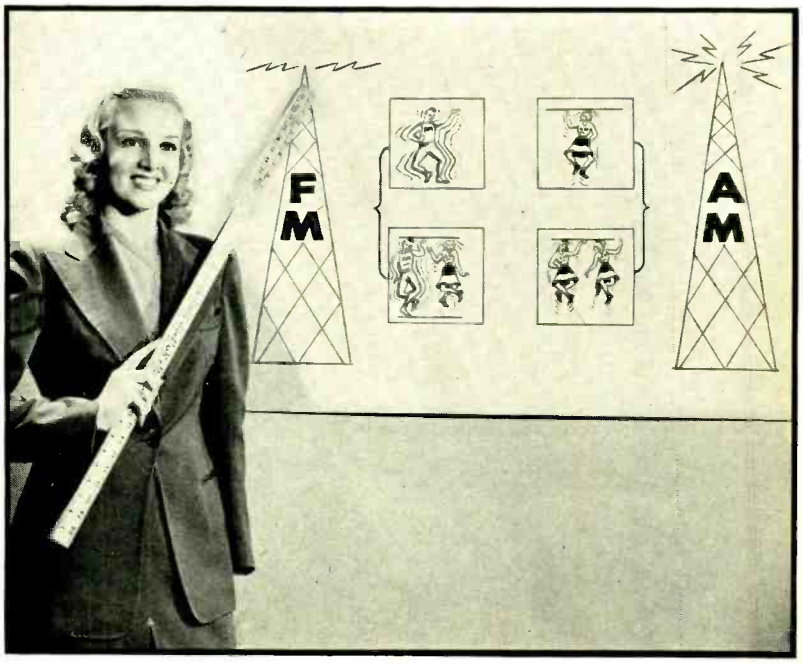
$$db = 10 \log \frac{P_1}{P_2}$$ where

P_2 = Power input in watts
P_1 = Power output in watts

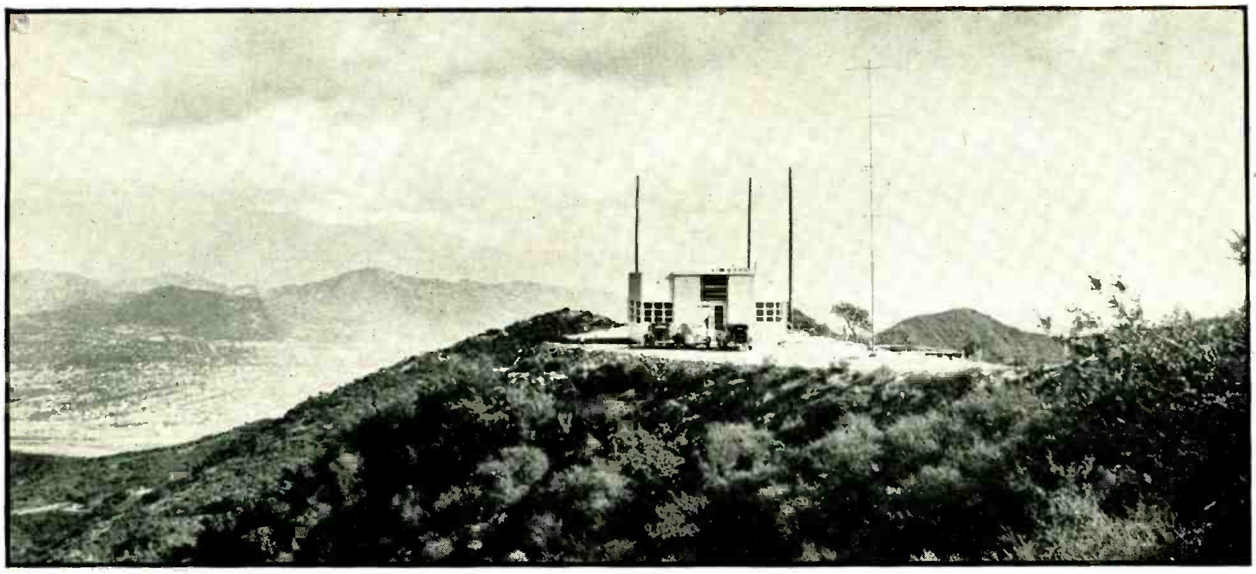
A much simpler method than working out this formula is to determine the number of db of output and the number of db of input from *Fig. 2,* then divide the first by the second.

While this discussion has not indicated the remedial procedures for correcting the troubles which may be found to be present in amplifying equipment, it has, it is hoped, given a fairly systematic picture of the procedure for determining the important characteristics of amplifiers. If after these tests have been completed, the equipment is found to have had the desired characteristics, there has still been a value in having made them, since it is often useful to be able to state the exact characteristics of audio equipment.

F.M. in Swing Time



Engineers have had a hard time trying to explain frequency modulation, so Betty Rhodes, singing star of the Mutual Network, got a bright and practical answer in modern language: she simply pointed out that the engineers were merely "swinging" the carrier wave instead of jiggling it up and down in a sawtooth pattern. The dancing figures in the boxes tell the story, and it's evident from the banging of heads at the right that amplitude modulation is a headache. The partners, in each case, represent distracting noises. Miss Rhodes is making it all very clear to the photographer, who still doesn't know what F.M. is. The chart was originated by Jack Myers, of the General Electric Co.



Don Lee's K45LA atop Mt. Lee in Hollywood. At right is 4-bay turnstile while the three black poles will support a-m antennas. The one-story structure has complete living facilities.

Don Lee's K45LA

FRANK M. KENNEDY*

◀ This article is intended to describe the general results of the Don Lee Broadcasting System's operation of frequency-modulation station K45LA, since its inauguration August 11, 1941, and to include information of interest regarding FM transmission and reception.

Don Lee became interested in FM when it was announced by Major Armstrong in 1936. Following publication of his article in the Proceedings, we designed, on paper, an FM transmitter in accordance with Major Armstrong's published circuits and data. This was abandoned in favor of purchasing a transmitter. Nothing further was done because we didn't have a suitable site for a high-frequency transmitter. When Mt. Lee, on the Hollywood Hills, was completed we took active steps to secure a frequency and buy a transmitter. Our pattern is based on the use of a six-bay turnstile antenna 160 feet high above Mt. Lee, or a total height of 1860 feet above sea level.

Initial Groundwork

In view of the fact that a 50-kilowatt transmitter could not be obtained immediately we decided to order a Western Electric 50-kilowatt unit but not wait for it before going on the air. Arrangements were made to secure delivery of a 1-kilowatt Western Electric and work was immediately started on leveling the east mountain peak. This peak was 300 feet long by about 100 feet wide at its maximum width and required the moving and leveling of 2000 cubic yards of rock and dirt. The result is a second level area about 7 feet lower than the area the television building stands on.

The distance between the television and FM building is about 450 feet, which will place their respective antennas about 500 feet apart. This was considered necessary because of our concern that the 50-kilowatt FM signal might get into the television cameras and cause interference. All telephone and power lines are buried to within 150 feet of either building and all lines are below the level of the top of the hill.

Don Lee has tried to keep ahead of the public demand in FM and television and to obtain the vital experience necessary to conduct successful operations in any new field. We have always believed in high fidelity and have tried to raise the standards of operation on AM channels to the maximum possible with this medium. The limitations inherent in a 10-kc channel and with the present AM broadcast allocation set-up preclude any substantial improvements beyond that which is now available.

FM presents the opportunity of obtaining the full advantages of, first, a 15,000 cycle audio frequency

*Chief Engineer, Don Lee Broadcasting System.

response; second, almost complete freedom from noise within the service area of the station; third, freedom from co-channel and side-channel interference, and fourth, comparative freedom from intentional jamming by an enemy of our broadcast FM frequencies.

Response Facilities

With respect to frequency response; our studios are equipped with facilities which are flat, by measurement, to within 1 db from 25 to 17,000 cycles. The noise level is a —65 referred to a —65 db microphone level. Obviously, it is useless to refer to a —65 db noise level unless you refer to a —65 db "below what."

If a microphone had a program output level of zero (6 milliwatt reference), it would be very simple to achieve a —65 db noise level below zero. On the other hand it is practically a physical impossibility to achieve a —65 db noise below a microphone output level of —85 because —65 below —85 is —150 as an absolute noise level, which is below the random noise level in the grid input circuit of the first or microphone amplifier. It would be an exceptional amplifier which would have an absolute noise level of —145 db below 0 db. The average pre-amplifier has a noise level of about —138. If six or eight of these are ganged together the average resultant noise will be in the neighborhood of —130 db below 6 milliwatts or —122 vu.

In passing, we might mention that random noise or hiss in a 15,000-cycle channel is about 4 db higher than in a 10,000-cycle channel. This is an additional burden born by the high-fidelity FM channel.

The amplitude distortion in these studios runs from less than 2% at 50 cycles to 0.5% at 400 and 0.5% at 7,500 cycles.

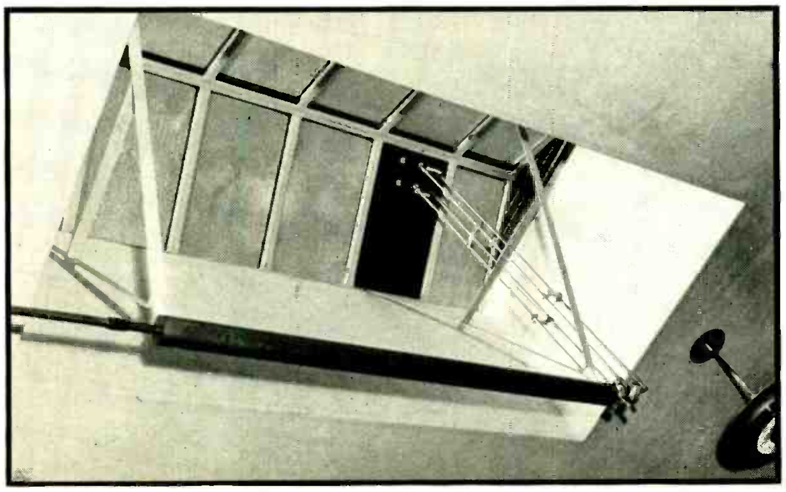
The output of the studios goes to the Master Control where the noise level is —70 db with an essentially flat frequency characteristic; then to the K45LA Announce Booth with a similar noise and frequency characteristic and then back to the Master Control room and then to a telephone program line to Mt. Lee. This telephone line is flat from 30 to 15,000 cycles within 6 tenths of a db. The noise is approximately —70 db below 6 milliwatts. There are no amplifiers or repeaters in the line between our Master Control and Mt. Lee, therefore there is no amplitude distortion. It is interesting to note that the Telephone Company uses a single inductance, capacity and resistance to equalize the FM telephone line to this degree of flatness.

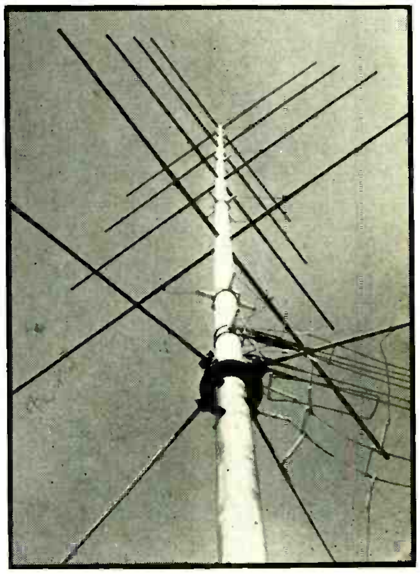
Notes on Receivers

The fidelity of the received and reproduced program is dependent on maintaining the frequency response and amplitude distortion of the studio speech equipment, transmitter and FM receiver to a high standard. The studio equipment and transmitter are within the control of the broadcaster and can be maintained in proper condition. The design of the receiver is in the hands of the manufacturer and in the great majority of cases, they have done an exceptional job of design work.

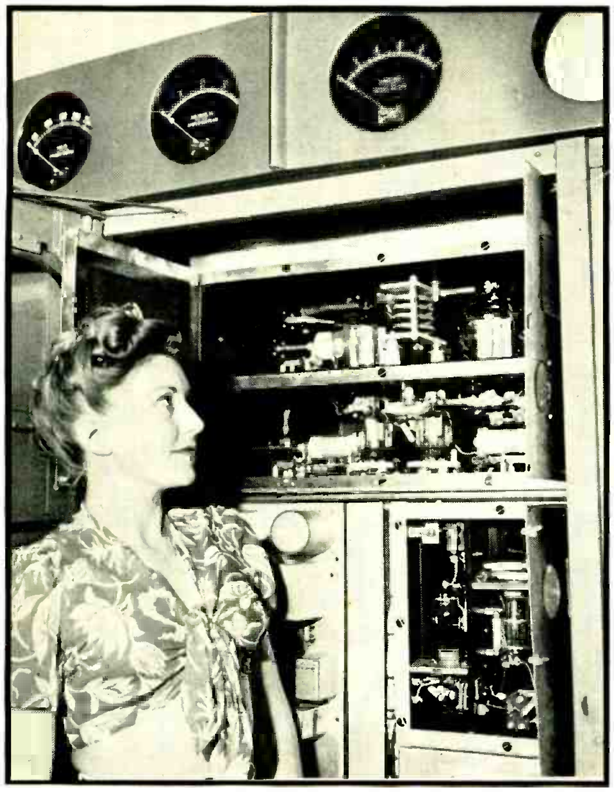
However, it is necessary to keep the adjustment originally made in the factory or severe amplitude distortion may result. We have run across some cases where receivers were not properly lined up and adjusted for K45LA when we received them. In these few sets the amplitude distortion was too high and they were critical to tune. Normally, there is a reasonable space at the "center" of the carrier where the signal will be clear and undistorted. When a receiver will not accept the full 75-kc swing there will

Unusual angle shot of control-room ceiling, showing output unit from transmitter to unbalanced to balanced transmission lines section, followed by 4-wire impedance transformation section feeding a 4-wire, 250-ohm transmission line, which in turn feeds the 4-bay turnstile.





Bug's-eye view of the 4-bay turnstile antenna at K45LA. It's 60 feet high and of dural tubing; was assembled on wooden horses and later raised, complete.



Virginia Simms takes an inside peek at the internal structure and arrangement of the Western Electric f-m transmitter at K45LA. Neat jobs, both.

be considerable distortion, particularly on peaks. Sometimes it is more noticeable when tuning from the center to one side or the other, of a carrier. In this case the heterodyne oscillator, i-f amplifiers, or discriminator circuits are not lined up or adjusted for a band-pass of at least 150 kc. Obviously, a wider band is desirable. Our experience has been that properly designed receivers can be adjusted for very low values of overall distortion.

Recently we took several receivers and lined them up with an i-f test oscillator; that is, a test oscillator whose frequency can be varied back and forth 300 or more kilocycles. With this instrument and a cathode-ray oscilloscope we made the proper adjustments to widen the i-f stages and align and flatten the discriminator circuit to permit well over 75-kc swing with very low distortion. In fact, one receiver was adjusted for 0.6% distortion at all frequencies between 50 and 7500 cycles at ±75-kc swing. However, some i-f gain was lost. Normally, distortions of 1.8 to 4% are easy to obtain with no loss in gain. Remember, this is overall distortion and includes the residual distortion in the test oscillator, speech equipment, transmitter, receiver i.f., discriminator, and audio amplifier circuits. A frequency response of ±2 db from 30 to 15,000 or 16,000 cycles is easy to obtain. The normal measured noise level is —60 db overall based on a ±75-kc swing.

You will note that a swing or deviation of 37.5-kc represents a signal 6 db below ± 75 kc and a 112.5-kc swing is 3 db above ±75 kc. If the i-f and discriminator circuits are sharply tuned the distortion will rise very rapidly with an increase in swing. If a General Radio or RCA Distortion Meter is not available, the receiver could be adjusted while looking at the picture of the 400- or 1000-cycle sine wave on a good cathode-ray oscilloscope.

We do not mean to give the impression that it is necessary to use a General Radio or RCA Distortion Meter to adjust an FM receiver after first lining it up with a frequency "wobbulated" oscillator. The Distortion Meter is just a means of "finessing" the distortion to the absolute minimum.

Noise is a factor which very definitely affects the fidelity of reception of either AM or FM signals. If the interfering noise is random in character, that is, like tube hiss, then the psychological effect is a tendency to mask the high frequencies. The full clarity, brilliance, and depth of a musical composition is impaired and the listener wants to turn down the tone control, if he has one. Random noise, such as telephone dial clicks or ignition noise is distracting in proportion to its peak intensity and frequency of occurrence.

FM has a 20 to 1 advantage in noise suppression or elimination over AM. That amounts to 26 db. In general, a noise peak can be considered as an interfering carrier signal. If the "carrier" frequency of the noise peak is the same as the station carrier frequency there will be no interference with no modulation on the carrier, because the noise will merely be added to the carrier and will result in amplitude variation which will be eliminated by the limiter amplifiers if limiter amplifiers are used. If limiter amplifiers or other suitable means are not employed to eliminate the amplitude modulation then this kind of noise will pass through the discriminator to the audio amplifier.

We have on order, and expect delivery very soon, a 50-watt ultra-high frequency FM transmitter to operate on 156 mc. It will be portable and include everything necessary to make a pickup anywhere within its radius of operation. This, we believe, will be 30 to 50 miles.

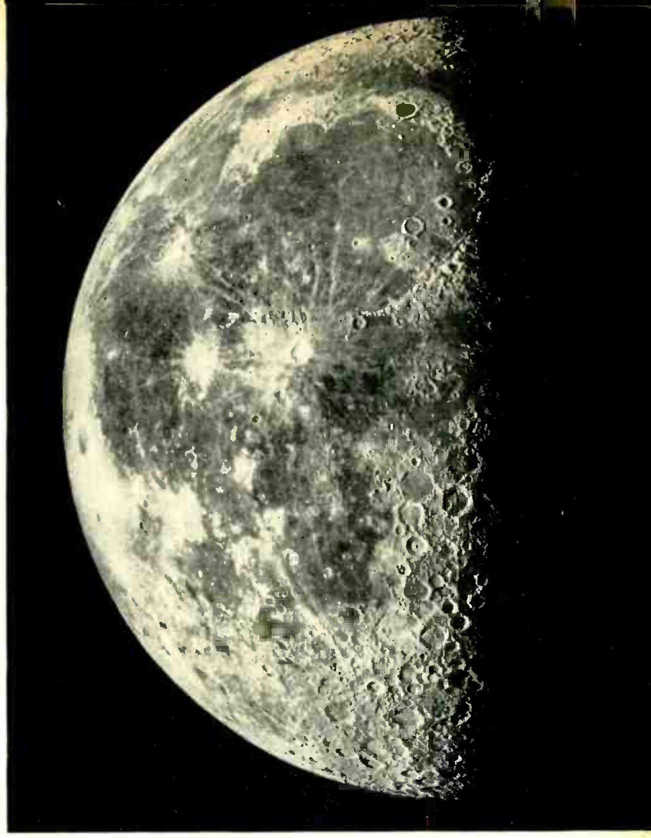
In practice the 156-mc unit will be used on special events and anywhere it is impractical to obtain a 15,000-cycle telephone program line. For mobile operation a 3-foot fish pole will be used.

A beam receiving antenna will be located on the east peak of the Mt. Lee area just beyond the FM transmitter building. This beam receiving antenna will be rotatable and can be turned by remote control from the transmitting operator's console position. It will be a comparatively simple matter to employ a directional receiving antenna with a gain of 10 or 15 db so that the 50-watt portable transmitter will look like a 100-watt unit at the receiver input on Mt. Lee. Thus, FM fidelity will be obtainable on remote pickups over a very wide area.

THE LUNAR

Photoelectric Effect on Radio Waves

PERRY FERRELL, JR.



MOON CRATERS, POSSIBLY FORMED BY RADIOACTIVE HEAT

◀ Recently Dr. Harlan T. Stetson, eminent investigator and director of the Cosmic Terrestrial Research Laboratory, announced his discovery of "moon rays" that positively affect E-layer ionization, and a good correlation to dx-ing between 100 and 600 meters is now indicated.

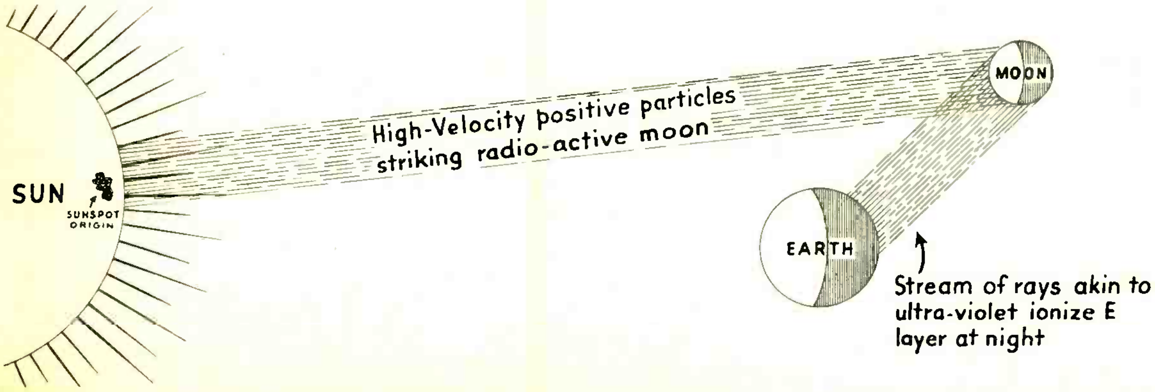
Dr. Stetson in basing his hypothesis upon field strength readings of WBBM, 780 kc, Chicago, Illinois, at his suburban laboratory of the Massachusetts Institute of Technology at Needham, Massachusetts, says, "The interpretation we gain is in the direction of increasing ionization with lunar age to an optimum value. . . . It is a simple fact that the light of the moon itself is too feeble to have any ionizing effect on the earth's upper atmosphere* and yet the fact that the ionization appears to depend upon the amount of the illuminated surface of the moon turned towards the earth has suggested some sort of photoelectric effect. . . . Furthermore, the fact that the effect is much more marked at sunspot maximum than sunspot minimum strongly suggests that the solar radiation falling upon the moon's surface is a primary factor.

"It is not possible to be too dogmatic as to the nature of the bombardment from the moon, just as it is not wise to say what type of 'ray' causes the lunar surface to become radioactive. There appear to be a very wide choice of particles, including high-velocity electrons, positrons, protons, neutrons, deutrons, alpha particles and cosmic rays, not forgetting the greater numerical strength of the potentially weaker photon. We can, however, assume that myriads of electrically-charged particles arriving from the sun at the speed of light strike the moon's surface and cause the probably raw element deposits there to become atomically excited, emitting strong gamma rays or something akin to ultraviolet light, whose high penetrating power affects the E-region ionization."

Dr. Stetson again points out that this is the result of several cycles of inter-locking factors. The

(*Continued on page* 58)

*Ultra-violet light from the moon amounts to 0.000044 ergs cm^{-2} sec.



It is suggested by Dr. Stetson that solar radiation from sunspots falling upon the moon's surface and thence reflected to earth is the source of "moon rays" that affect E-layer ionization.

The Cathode-Ray

OSCILLOSCOPE

JAY BOYD*

Part II—Practical Oscilloscope Design

In the March issue, the theory of cathode-ray oscilloscopes and sweep circuits was discussed with the object of introducing this most useful piece of apparatus. This installment will be devoted to practical design, so the reader may build a one-, two-, or three-inch oscilloscope that will compare favorably with commercial instruments of comparable size.

This will not be an academic text on the subject but will be written around certain specifications which experience has shown to be practical, even if not always ideal. The reason for selection of certain values will be given in many cases, and the effects of changing these values explained.

Last month we mentioned that the general purpose oscilloscope was made up of five units; that is, the cathode-ray tube circuit, the vertical amplifier, saw-tooth oscillator, horizontal amplifier and a dual power supply for all units.

There is practically no difference in circuit design, whether one builds his 'scope around a one- or two-inch tube. A three-inch job will require more voltage for the cathode-ray tube but the saw-tooth oscillator, amplifier and switching arrangement will be identical for all models. Circuit design will be considered first, with suggested physical layouts being given in the third installment.

Selecting the Tube

Whether to use a small cathode-ray tube or a larger one is a problem each builder must decide for himself. The larger tubes produce bigger patterns, of course, but a little 913 will show up faults of the apparatus under test just about as well as a three-inch tube. The larger screen is much better, though, where accurate measurements of the pattern are made by a ruler or dividers on the screen.

On the other hand, the smaller jobs may be much more compact. We know of one geophysics laboratory that uses a five-inch 'scope "at home" but takes little one-inch 'scopes out in the field. They are more portable and less liable to accidental breakage.

Although the writer has built several oscilloscopes using both one- and two-inch tubes, he has used one of the smaller ones for three years. Building that two-inch job for himself is an event still hanging on the calendar, parts having been on hand for months. Experience with three-inch jobs has been that of using and repairing a few commercial jobs that went on the rampage.

To familiarize the reader with several of the more suitable cathode-ray tubes, the accompanying Comparison Table has been prepared so their size, operating voltage, and deflection sensitivities may be compared.

In addition to the manufacturer's specifications, some of the sensitivity ratings have been recalculated for the actual voltages obtained from a Thordarson 92R33 transformer, operating from a 117-volt

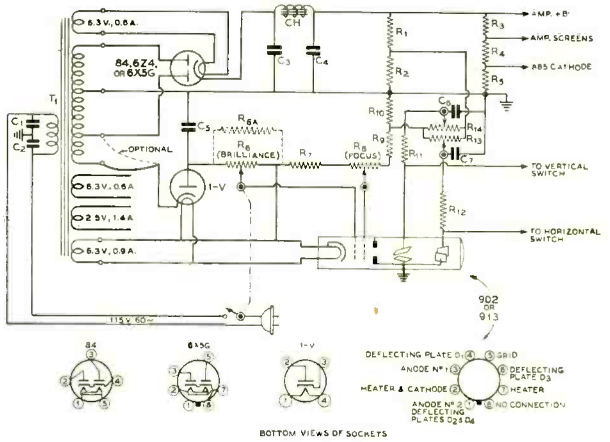


Fig. 1. Schematic diagram of complete power supply suitable for any one- or two-inch cathode-ray oscilloscope tube. Design data given in text.

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*2468 Lyric Avenue, Los Angeles, Calif.

CATHODE-RAY TUBE COMPARISON TABLE

Tube Type	913		902		XH-24		3AP1/906
Diameter of Screen	1"		2"		2"		3"
Length Overall	4 3/4"		7 7/16"		7 5/8"		11 1/2"
Heater Voltage	6.3		6.3		6.3		2.5
Heater Current	0.9		0.9		0.9		2.1
High-voltage Electrode (Anode No.2)	250	375[1]	375	440[2]	375	440	1000
No.1 (Focusing) Electrode, approx.	50	75	94	110	75	88	285
Grid Voltage required for safe cut-off, approx.	30	50	50	60	50	60	50
Deflection Sensitivity - mm. per volt, d.c.[3]	0.15	0.10	0.30	0.26	0.27	0.23	0.33
Volts per Inch Deflection, d.c.	167	250	83	96	94	108	75
Volts d.c. for half-screen deflection	83	125	83	96	94	108	112
Volts a.c. for full-screen deflection	59	88	59	68	66	76	79
Saw-tooth Voltage (peak-to-peak) for full sweep	167	250	166	192	188	216	224

1 This voltage, plus stated grid potential, is based on actual voltage obtained from transformers referred to in text, using low tap.
2 " " " " " " " " " " " " " " " " " high "
3 All sensitivity figures given refer to front set of deflector plates. Rear plates are slightly more sensitive.

Handy table from which the size, operating voltages and deflection sensitivities of four types of cathode-ray oscilloscope tubes may be compared.

line, both with and without the high-voltage tap in use.

To furnish more useful figures, sensitivity has been calculated in d-c volts per inch, d-c volts for half-screen deflection, and a-c potentials necessary for full-screen deflection. The d-c voltages given are those required to shift the beam from the center of the tube to its outer edge. The a-c voltages shift the beam in both directions, of course, so the figures given are those necessary to touch both edges of the screen.

From the Comparison Table we find, that for a given voltage, the deflection sensitivity in millimeters per volt is approximately proportional to the diameter of the screen. However, the voltage necessary for full-screen deflection is roughly the same, regardless of tube size. That is, a little more or less than a hundred volts will be required for the pattern to touch all edges of the screen.

It can be seen, then, that any saw-tooth oscillator and amplifier arrangement designed for one type of tube will be suitable for any other tube listed. The only difference in circuit design and component selection will be in the power supply.

Power-Supply Requirements

The high-voltage anode potential is not at all critical. A 913 will operate on any voltage from about 250 to 500; the two-inch tubes from 300 to 600 volts, and the three-inch tubes from 600 to 1500 volts.

In addition to the anode voltages, which are measured from cathode to high-voltage anode, the cathode-ray tube's grid bias of 30 to 75 volts is also taken from the power supply.

Since the high-voltage anode is grounded, all power supplied to the cathode-ray tube must be of a negative potential. The amplifiers and saw-tooth oscillator require power of a positive character. This, then, makes it necessary to employ either two separate power supplies, or else a dual affair, the latter being more often used.

Designing the power supply is a simple matter. The trouble comes in getting the right transformers. If you're building a one-inch 'scope the solution is fairly simple; if it's a two-inch job, it becomes a problem; and a three-inch oscilloscope may become a headache.

Four separate circuits for c.r.o. power supplies are shown. *Figs. 1* and *2* are preferable—if you can get the right transformers. But *Figs. 3* and *4* are usable if you have to get along with whatever you can get, and if proper care is used in separating the c.r. tube and transformer.

Dual Supply for Small Tubes

Fig. 1 shows a dual power supply built around a Thordarson 92R33 cathode-ray power transformer. This produces a d-c potential of 400 volts for the saw-tooth oscillator and amplifiers, and either 425 or 500 volts negative for the cathode-ray tube, depending on whether or not the high-voltage secondary extension tap is used.

A California manufacturer, Hadley, also makes a similar transformer, except that it does not have this h.v. extension tap.

The positive portion of this supply is quite orthodox, except for using one more bleeder than one might expect to find. On the negative side we find a half-wave rectifier connected "backwards" so as to get a *negative* output. The current taken from this rectifier is less than two milliamperes, so a single filter condenser, without choke, is all that is required for ample filtering. Both rectifier tubes are of the "automobile type," instead of the expected 80's.

Four filament windings are used. The amplifiers cannot operate from the same filament winding as the rectifiers or cathode-ray tubes.

Inserted in the negative bleeder are two potentiometers, *R6* and *R8*, which control the cathode-ray beam intensity (brilliance), and focus of the tube.

Note that the cathode is *internally* connected to one side of the heater in the c.r. tube and *this side only* must be connected to the junction of *R6* and *R7*.

In the typical cathode-ray tube circuit shown in Part I the free deflector plates were returned directly to ground through their respective resistors. This is usually ok with 913's but seldom practical with larger tubes.

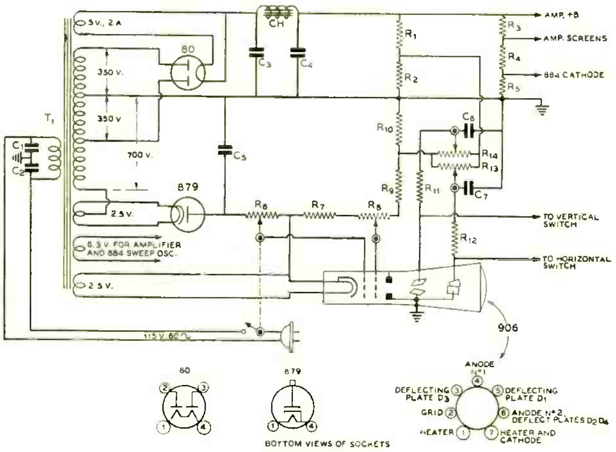


Fig. 2. Schematic diagram of power supply for three-inch cathode-ray oscilloscope tubes. The power transformer must be designed for this purpose.

Although the electron gun may be perfectly centered on the screen, the beam is usually a bit off center, due to attraction of nearby apparatus or the earth's magnetic attraction. And if you think that last mentioned point sounds like nonsense, just lay an oscilloscope on its side or turn it upside down and watch the beam shift!

So instead of returning directly to ground these "free" plates may be given a moderate position or negative bias to place the beam where it should be. This bias is taken from the two potentiometers, *R13* and *R14*, which "straddle" a portion of both negative and positive bleeders.

A potential of about 75 volts is usually ample to either center the beam or purposely lower it for certain classes of work.

One may wonder why the positive ends of these potentiometers were not returned to the middle of *R2*. It can be done if you're careful, and patient in juggling resistors. But unless you are looking for a lot of grief you'd better not be too stingy with an extra resistor or two. This is done in some commercial 'scopes—and some of them even omit *R10*, thereby saving another resistor and making the wiring more confusing when one has to tear into it. The separate bleeder also makes it easier to increase or decrease the maximum value of bias, should the occasion arise.

If a one-inch 'scope is built, the beam centering parts may be omitted. But provide room to add them if it should become necessary. Without these parts, *R13* and *R14* will connect to ground.

Bleeder and Filter Design

The main positive bleeder is designed for a bleeding current of five milliamperes. The 885 cathode current will vary from 0.075 to 0.550 milliampere, according to the saw-tooth oscillator frequency, so adding a five-mil drain across *R3* will raise the cathode 3.8 to 4.15 volts above ground.

The amplifier screens require half a mil per tube at 100 to 125 volts. Using 50,000 ohms in *R1* and 20,000 ohms in *R2* completes the bleeder.

The beam centering bleeder should draw about the same current as the negative bleeder, or about 1.5 mils. A quarter-megohm in series with 50,000 ohms will be about right, but may be changed if more centering bias should be desired.

The total current taken from the full-wave rectifier will be about 13 mils, so is easily filtered. Any 20-millihenry midget choke will be satisfactory, with a filter condenser before and after it.

Paper condensers should be used, since experience has shown the voltages encountered too much for

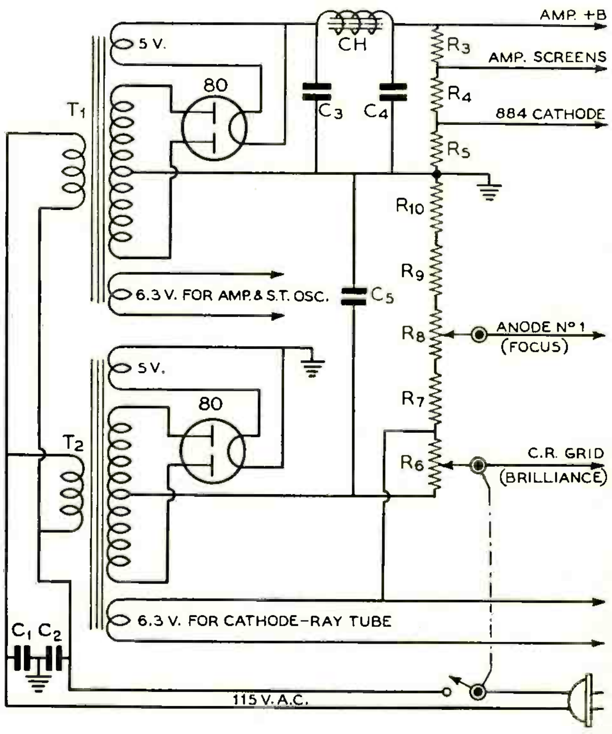


Fig. 3. Schematic diagram of a two-transformer power supply for a type 913 oscilloscope tube. The transformers are of the radio-receiver replacement type.

electrolytics. Paper-wound replacements are recommended. The actual capacity of such condensers is about 1.75 microfarads per section for typical "8-8" replacements, but that is ample.

The Negative Bleeder

Cathode-ray tubes thrive on lots of voltage but consume almost no current. The anode current will seldom exceed one-quarter of a milliampere for any

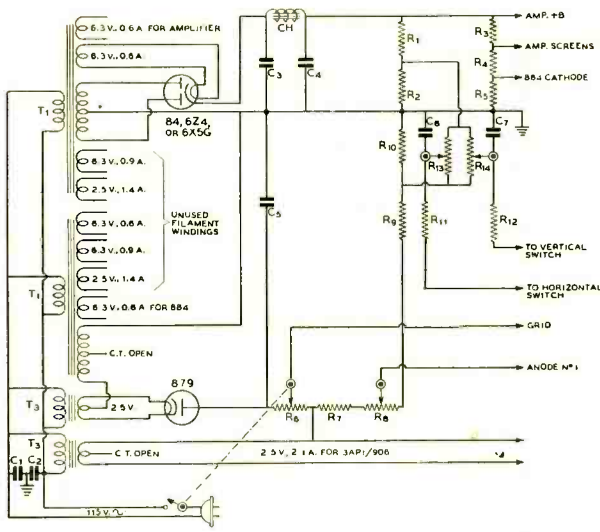


Fig. 4. Complete schematic of a four-transformer power supply for a three-inch oscilloscope tube. Here again, replacement-type transformers can be used.

tube up to three-inches diameter, and only a fraction of this current is drawn by the focusing anode.

From an electrical point of view most any bleeder current should be ok, but from a practical angle certain factors must be considered. If the resistance is too high, a variation of the brilliance control may necessitate a slight readjustment of the focusing anode voltage. Too low resistance will cause a heavier current drain and may require more filter than the single condenser shown.

A current drain of from one to two milliamperes will be satisfactory. The resistors specified are based on a drain of 1.5 mils so a "single-8" replacement (about 2.75 actual μfds.) will keep the ripple down to six tenths of one percent.

It should be noted that whatever voltage is dropped across *R6* is lost, insofar as the c.r. tube is concerned, its actual operating potential being that measured from cathode to its grounded anode. A 50,000-ohm potentiometer at *R6* should give sufficient grid bias to completely cut off the beam current with any c.r. tube mentioned in the tube table.

But 75 volts is more than we may care to rob from the c.r. tube. In practice, one-half to two-thirds this voltage will reduce the beam intensity to such a low value that no fluorescence appears on the screen. Now if a half-watt resistor of 50,000 or 100,000 ohms is placed in parallel with *R6,* more voltage will be saved for the c.r. tube. After connecting this resistor, turn both vertical and horizontal gain controls to zero and see if a spot can be seen in a darkened room. If it is visible a larger value of *R6A* will be necessary, or else the beam must always be kept in motion to avoid burning a dead spot in the center of the screen.

Another method is that of connecting a jumper from the *R6* slider to rectifier plate. This places maximum voltage on the c.r. tube. It has the disadvantage, though, of changing the sensitivity of the tube slightly as the beam intensity is varied, which may be objectionable.

Using Substitute Transformers

The power supply diagrammed in *Fig. 1* is designed around Thordarson or Hadley transformers, the only ones known available. These were designed for the 913 tube, for which they are quite satisfactory. They produce ample voltage for two-inch tubes, too. Oversize cores are used to minimize magnetic field radiation, which is less than half that of ordinary receiver transformers of equal size. But alas, their fields are still much more than we would wish for two-inch tubes!

Some day, when the war is over, maybe someone will build a transformer with plenty of high-permeability core, electrostatic shielding between windings, and then put it in a high-conductivity case thick enough to keep those cussed fields inside. And then we can build a two-inch 'scope as compact as it should be. But now we must just be satisfied with what we can get.

Fig. 2 is designed for a three-inch tube on the assumption that a suitable cathode-ray transformer may be had from the maker of the tube, and is self-explanatory.

Fig. 3 is designed around two small receiver replacement transformers, and should be used only if a regular c.r. transformer is not available. It should be ok for the 913 tube and can be used for a two-inch tube if *plenty* of space is used between tube and transformers.

Both transformers should be identical and of the 50- or 60-mil size in order to get more core and less magnetic field floating around loose. It would be better to get 25-cycle transformers, which have more core, using them on 60-cycle current, if they should be obtainable. The thought of shielding occurs, but this requires a lot of weight to have much effect.

Fig. 4 is a four-transformer supply for three-inch tubes. Two of the aforementioned c.r. transformers are used, plus a pair of 2.5-volt midget filament transformers. Two 60-mil replacement transformers could also be used in this arrangement, with careful spacing. An 879 rectifier is shown, although some oscilloscope manufacturers use an 81; others overwork our old reliable 80 but seem to get away with it.

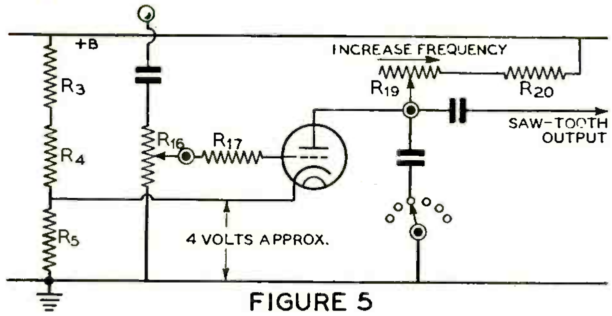


FIGURE 5

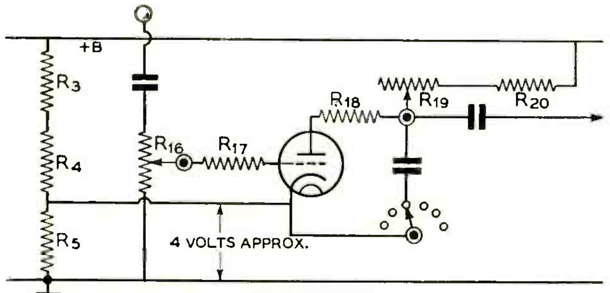


FIGURE 6

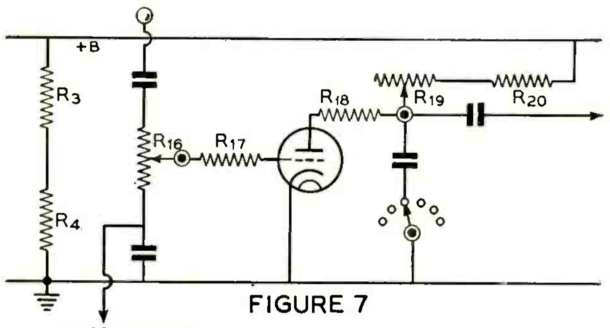


FIGURE 7

Diagrams of three relaxation oscillators, all operating on the same principle. Either Fig. 6 or Fig. 7 is to be preferred for the generation of a saw-tooth wave. All three are explained in the text.

Designing Saw-Tooth Oscillator

The theory of the relaxation oscillator was discussed last month, but will be briefly repeated. In *Figs. 5, 6,* and *7* are shown three such circuits, all operating on the same principle.

An appropriate tank condenser, selected by the rotary switch, is charged by current from the d.c. supply. *R19* regulates the charging rate, while *R20* prevents this rate from becoming excessive.

When the condenser is charged to a certain potential, the gas-triode[1] tube flashes, discharging this condenser to almost zero. Then the charge-discharge cycle begins all over again.

The potential at which the gas-triode tube flashes, is determined by the negative bias on its grid, this bias being supplied by tapping the cathode about 4 volts[2] up on the bleeder circuit in *Figs. 5* and *6,* or by a fixed bias, as in *Fig. 7.*

The frequency of oscillation is determined by the value of tank condenser, its rate of charge, and the potential at which it is discharged.

This frequency may be synchronized to that of the signal under observation by feeding a small portion of that signal back to the oscillator tube's grid, the amount of feedback being adjustable by the potentiometer, *R16.* A grid resistor, *R17,* prevents instability of oscillation.

The output voltage from the oscillator will be equal to the flashing potential at which the tube is biased to operate, minus the de-ionization potential of the tube. The tank condenser is never completely discharged. When discharged to a certain low potential —10 or 15 volts—the gas tube again becomes a nonconductor and the charging cycle begins anew.

The oscillator's output voltage rises at a constant rate but discharges instantaneously, producing a waveform looking like the teeth of a saw, whence gets its name.

Fig. 5 looks all right on paper but in practice has such a long discharge time as to be unsatisfactory. This is because discharging current must pass through the biasing resistor, *R5,* which lengthens the discharging time.

By connecting the switch arm to the cathode instead of ground, as shown in *Fig. 6,* a very fast discharge is obtained. To hold the discharge current to a safe value for the tube, a small resistor, *R18,* is added in the plate circuit. A value of 200 ohms protects the tube and still permits a very fast discharge. As for tube life—well, one tube has been used for four years.

Another good oscillator circuit is shown in *Fig. 7.* Here a fixed bias is supplied by a "C" battery or from the power supply.

Either *Fig. 6* or *Fig. 7* will be satisfactory, choice being somewhat a matter of preference. In either circuit the current consumed by the oscillator will increase with the oscillation frequency. In case of *Figs. 5* and *6,* this increasing current will increase the bias, which will proportionately increase the "flashing" potential. This, in turn, results in increasing output as the frequency is increased, making it necessary to reduce the horizontal amplifier gain if a pattern of constant width is desired. This is a minor nuisance at frequencies below 10,000 c.p.s. but above that frequency the increased output may be an advantage, compensating to some degree for the falling off in oscillator output.

If fixed bias is used, the output will be essentially flat up to about 10,000 c.p.s., at which point the output diminishes rapidly. It is preferable, then, to use a little more if *Fig. 7* is chosen.

(To be continued)

[1]The writer wishes to correct a slight error in which the 885 was referred to in Part I as a "thyratron." This is a trade name of a particular make of grid-controlled rectifier, but has, through common usage, been loosely applied to all tubes of this general type. It is strictly correct, then, to use this name only in reference to the General Electric product.

[2]This refers to actual voltage and should be read on a voltmeter of very high resistance. If a 5-volt, 1000-ohms-per-volt meter is used, a much lower than actual voltage will be indicated.

U. H. F. . . .

PERRY FERRELL, Jr.

A frequent question encountered in dealing with u.h.f. propagation is about ionization. "What is ionization exactly?" and "We know there is an ionosphere, but just how does it get there?" are common examples. Suppose we digress a little from u.h.f. and look into this ionization of the earth's upper atmosphere.

Ionization may be thought of as the breaking up of a neutral gas molecule into its positive and negative constituents, the negative constituent being the light and very mobile electron, and the positive particles being the much heavier and more sluggish ion. Among the causes which produce ionization of the atmosphere may be mentioned the ultra-violet light from the sun and direct bombardment of the outer region of the atmosphere by electrons (viz.) thrown off from the sun, notably sunspots.

These freed electrons have varying potential gradients which accordingly vary their movement in the ionosphere. Now, if ionization has taken place in regions where the gas molecule population is sparse, the individual ion and electron may move about for a long time before they meet one of the opposite affinity; therefore ionization at these high levels is more or less persistent, and at the outer reaches of the F layer ionization is probably present at all times, because of stray rays arriving from inter-stellar space. Of course, this does not imply that ionization would rise indefinitely, because this would be limited by the electron or gas molecule population itself. Naturally, the reverse process also takes place, namely de-ionization or recombination. As the lone particles move about, their magnetic fields attract those of the opposite affinity and a union takes place—only to be destroyed again in a short time by ionization, and so the process completes a cycle.

The fluidity of movement is a product of the energy of ionization and re-combination and is realized as heat. In fact, the actual rare air temperature at the base of the E layer is probably very close to the boiling point of water (around 206 degrees F.).

These electrons, etc., arriving from the sun vary in potential to such a degree that either normal ionization (the action of a high velocity particle striking a neutral molecule and exploding or jolting loose some of the electrons) or that of an extremely high potential particle causing the free ions and electrons to enter into an excited state and glow or vibrate, as in aurora (also your neon sign).

Naturally, there are numerous other factors affecting the ionosphere, and a full treatment of the subject would require probably volumes of material. Principally, however, we must recognize the fact that the earth's magnetic field "return circuit" through the ionosphere influences the motion of the free electrons and ions therein.

Open Letter

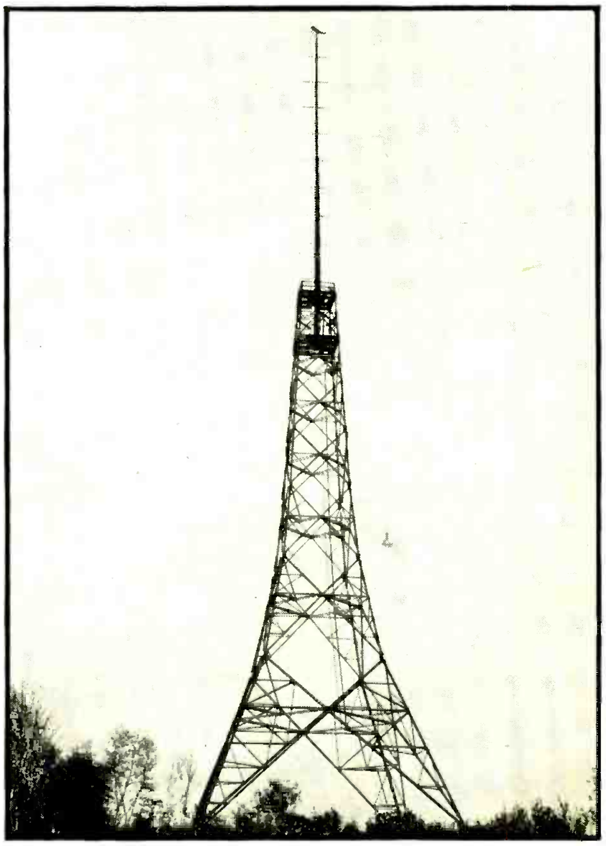
Dear Fellows:

You know, we just can't grasp the conception that you have all either fallen asleep or believe the u.h.f. is a washout for the duration. It just doesn't seem quite right, somehow.

We shouldn't think it would be necessary to recount our past exploits; how the present use of the u.h.f. is the direct result of amateur activity; how a small group has worked tirelessly and endlessly in the foundation of our present operating technique, and how many of our technical developments are now incorporated in commercial and military designs.

And yet, somewhere there has been a slip up; somewhere the gang has "missed the bus." You will

(Continued on page 50)



The 10-bay turnstile for W43B, constructed after the top collapsed in an ice storm.

NOISE LIMITERS

MANUAL AND AUTOMATIC TYPES FOR UHF AND BC RECEIVERS

W. P. BOLLINGER

RCA Manufacturing Co., Inc.

◀ Noise limiters are of great importance for receivers used on the higher frequencies where impulsive noises of the ignition type may be many times the strength of the desired signal. When choosing a noise limiter, selection may be made from two broad classes, the manually-controlled and the automatic types.

The manually-controlled type has one advantage over the automatic limiter in that it may be adjusted to accommodate the peak modulation of the signal being received. It then produces slightly better limiting action than the automatic limiter which is set to always cut off at one predetermined modulation level. The automatic limiter, however, has other advantages which greatly outweigh that of the manually-controlled limiter. No additional controls or adjustments are required. The limiter may be wired directly into the circuit becoming an integral part of the receiver, the noise limitation being equally effective for all values of received signal strength. The automatic limiter has one other important advantage which applies equally well to receivers used on the lower frequencies in that it produces considerable quieting action when the receiver is tuned between stations.

With a noise limiter operating directly after the detector, it is necessary to limit only one side of the audio output since the other side is limited by the detector; that is to say, noise impulses cannot produce more than 100% modulation in the negative direction, the condition corresponding to zero carrier, but may modulate the carrier in the positive direction to several hundred percent. The noise limiter is then only required to cut off all modulation in excess of 100% in the positive direction. Several different types of limiters are available which will produce this chopping, all of which may be automatically controlled.

The "Shorting" Shunt Limiter

Fig. 1A shows the fundamental circuit of a limiter designed to short circuit the detector output when the output voltage reaches a predetermined value. A voltage E is used to bias the limiter diode so as to make it non-conductive to the audio voltage developed across R until point *1* becomes sufficiently negative to overcome this bias. This limiter would then allow all voltages less than E volts to be passed on to the amplifier. If the limiter is to cut off at 100% modulation, then E must be twice the d-c voltage developed across R since audio peaks will swing point *1* to twice the d-c voltage appearing across the detector load.

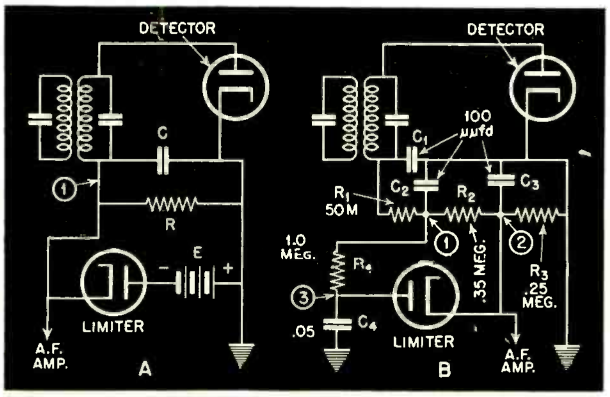


Fig. 1. The "shorting" shunt type of limiter. "A" is fundamental circuit. "B" provides automatic variation of limiter bias.

A circuit for automatically varying the limiter bias to accommodate different signal strengths is shown in *Fig. 1B*. The detector load resistors *R2* and *R3* are of such values that point *1* is at about twice the d-c potential above ground as point *2*. The voltage at point *1* is used to bias the limiter diode by feeding it through the filter network *R4* and *C4* which eliminates any audio voltage from point *3*. Then when a noise corresponding to greater than about 100% modulation occurs, it is shorted out through the limiter and *C4*.

The shorting limiter is very simple from the standpoint of adding it to a present receiver, but it has several disadvantages. All noise pulses which are limited must pass through *C4*. This condenser tends to build up a charge which biases the limiter higher, making it less effective. General indications are that the shorting limiter is satisfactory for rather high signal-to-noise ratios, but that with weaker signals and higher noise levels the limiting action is unsatisfactory.

The Balancing Shunt Limiter

Fig. 2A shows the fundamental circuit of a limiter in which the noise impulses are balanced out in the detector circuit. Normally, only the detector is functioning, but on noise pulses which overcome the bias *E* the limiter diode also begins to detect. The current it produces in *R* is opposite to that produced by the detector and so the noise is canceled out. The relative value of *E* may be found as follows: Assume a d-c voltage of 1 volt developed across *R*. At the peaks of 100% modulation, where we wish to cut off, the voltage at point *1* or across *R* will be a negative 2 volts peak. The r-f voltage across the i-f transformer must then also be about 2 volts peak. Point *2* will then reach a peak voltage equal to the sum of the i-f secondary voltage and the voltage across *R*, or 4 volts peak. From this it is seen that in order to have the limiter begin conducting at 100% modulation the voltage *E* must be four times the d-c voltage appearing across the detector load.

An additional rectifier may be used to secure the limiter bias, as shown in *Fig. 2B*. Excitation for this rectifier is taken from the primary of the i-f transformer. Since the limiter bias must be four times the d-c voltage developed by the detector, the primary of the i-f transformer must have four times as much r-f voltage across it as appears across the secondary. This is accomplished by loading down the transformer by *R1* and decreasing the coupling until limitation at 100% modulation is obtained. Either a regular transformer may be modified or one may be purchased which is especially designed for this circuit (see diagram).

As in the shorting limiter, the noise pulses must pass through a condenser *C4* but in this case the charging current is limited to a low value by the detector load resistance. Noise reductions greater than 20 to 1 are possible with this circuit with all values of signal strength. One objectionable disadvantage lies in the reduction in gain and selectivity as a result of the loading on the i-f transformer.

A simplified modification of the balancing shunt limiter is shown in *Fig. 2C*. Since impulsive noise is made up mostly of high-frequency components the noise may, to a degree, be separated from the signal by a high-pass filter. Such a filter, made up of *R3* and *C3*, is placed in the limiter diode of *Fig. 2C*. Noise impulses are then detected by both the detector and the limiter, but since the two are in opposition the result is that the noise is balanced out in the detector load. A tone control may be combined with this limiter by adding *C4* and *R4*. Better limiting action with some sacrifice in highs may then be obtained by reducing *R4*.

This limiter is not as effective as other types and will limit only certain types of noise. It is, however, very easily added to an existing receiver and might be put in a classification as being better than no limiter at all. It has been used with some degree of success on the sound channel of television receivers.

The Series Limiter

The fundamental circuit of the series limiter is shown in *Fig. 3A*. This limiter is conducting at all times until the voltage at point *1* exceeds *E*. The limiter then opens up and the noise pulses are not allowed to pass through to the audio amplifier. By the same analysis as used for the shorting limiter of *Fig. 1* it is seen that the voltage *E* must be twice the d-c voltage appearing across the detector load. This analysis applies only when the a-c resistance of the audio amplifier is very high. When appreciable audio load is present the a.c. flowing through the limiter is determined not only by *R2* but is increased because the a-c resistance now becomes the parallel combination of *R2* and the a-f load. For this reason the d.c. flowing through the limiter must be increased by increasing *E*.

Automatic bias for the series limiter may be obtained through the use of a voltage doubler, as shown in *Fig. 3B*. The voltage doubler functions as follows: Point *1* will charge up to a negative potential about equal to the peak r-f voltage appearing on the secondary of the i-f transformer. When the limiter bias diode conducts the voltage applied to it, it is then the voltage at point *1* plus the r-f voltage of the transformer, or twice the voltage at point *1*. Point *3* will

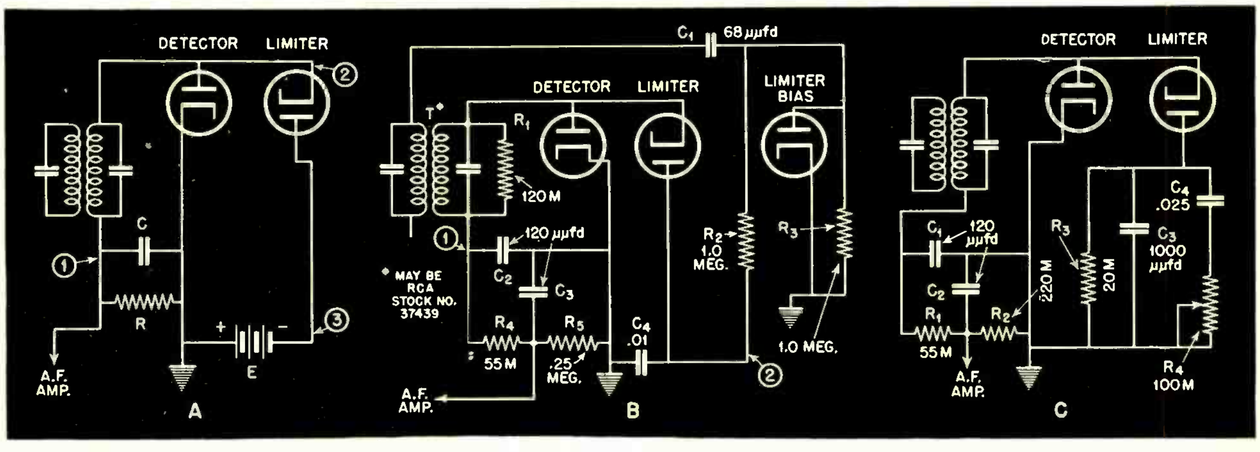


Fig. 2. Circuits of "balancing" shunt limiters. "A" is fundamental circuit. "B" uses separate diode for limiter bias. "C" is a simplified modification.

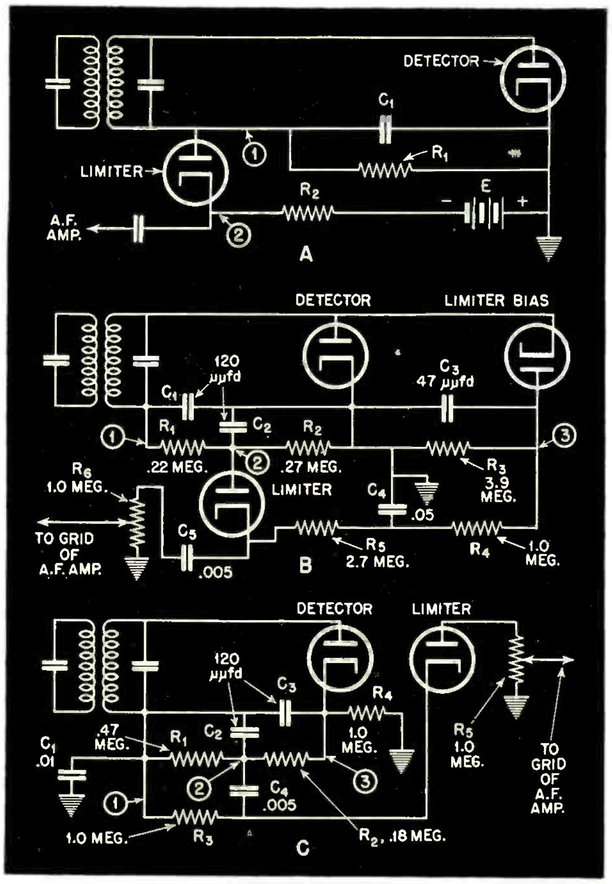


Fig. 3. Diagrams of series limiters. Fundamental circuit is shown at "A". In circuit "B" a voltage doubler is used to provide automatic bias. Circuit "C" is a simplification. Here the limiter bias is derived directly from the detector load resistance.

then charge up to a negative potential equal to twice that at point *1*.

The limiter bias is fed through the filter *R4* and *C4* to eliminate the audio components, and biases the limiter. As previously stated the limiter bias voltage must be higher than twice the d-c voltage across the detector load in order to take care of the a-c load represented by *R6*. This is accomplished by tapping down the detector load resistance so that the d-c voltage at point *2* is reduced, resulting in higher limiter bias and also reducing the a-c voltage. Both of these effects add together to make the limiter cut off at a higher modulation level. If the audio load were taken at point *1* instead of point *2* the limiter would cut off at a relatively low modulation level, resulting in distortion.

The series limiter is very good for limiting high amplitude noise pulses, since it is not necessary for the noise pulse to pass through a condenser which can charge up and alter the bias. Noise reductions of greater than 20 to 1 are obtainable. It also has an advantage over the shunt limiter in that with the series limiter it is not necessary to have a loss in the i-f transformer due to loading and decoupling. This not only improves the gain but also the selectivity.

A simplified modification of the series limiter is shown in *Fig. 3C*. Here the limiter bias is derived directly from the detector load resistance. The bias for the limiter diode is taken from points *1* and *3* and is fed through isolating resistors *R3, R4*. and *R5*. Point *2* is at nearly the same potential as point *3* since *R2* is a rather small isolating resistor. As far as audio is concerned, point *1* is at ground potential because of the large bypass *C1*, and so the detector audio output appears across *R3*. Now since the peak audio voltage at 100% modulation is equal to the d-c voltage across the detector load, and since this d-c voltage is used to bias the limiter, it will cut off at about 100% modulation.

This modification of the series limiter produces limiting action which is as good as that obtained by the circuit of *Fig. 3B*. It has one disadvantage, however, in that some diode biasing is applied to the a-f amplifier. With high-gain amplifiers, such as the 6SQ7, some distortion may, as a result, be produced. It is impractical to add a coupling condenser and grid resistor after *R5* since this will make the a-c load resistance lower than the d-c resistance. This condition, it has been shown, will make the limiter cut off at a lower level, producing distortion.

Conclusions

Of the three general types of limiters presented here, the shorting type of *Fig. 1* should be discarded if limiting action at high noise levels is to be obtained. It has found application in some commercial amateur receivers, but tests have indicated that it is not so good as either the series or shunt limiter.

(*Continued on page* 54)

ANSWER TO CROSSWORD PUZZLE

Appearing on page 52, March issue

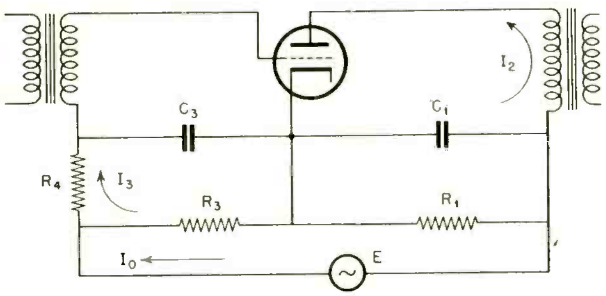
C	O	N	E		T	A	P		B	A	N	D
O	V	E	N		A	T	E		I		H	Y
N	O	T	E		R	O	D	M	A	N		N
D	L			G	E	M		E	S		P	A
E	O	N		A		I	C	W		P	O	T
N		O	F		R	S	T		E	A	S	R
S	E	N	O	R		M		R	A	D	I	O
E		A	N	A	M		W	O	O		O	N
R	E	G	E	N	E	R	A	T	I	O	N	
	R	O		G	D		I					O
A	G	N		E	I	N	S	T	E	I	N	S
H	O		D		A	R	T		R	O	T	C
A	N	T	E	N	N	A		F	I	N	A	L

RADIO DESIGN WORKSHEET

NO. 1—AUDIO CIRCUITS

TRIODE AMPLIFIER

Problem 1:—*The accompanying diagram illustrates a simple triode amplifier with grid filter and power supply potentiometer. Voltage E consists of a d-c and an a-c component. Determine the relations between C_1, C_3, R_4 and R_3 for which the a-c component of I_2 due to E will be zero. Assume no signal voltage impressed on the tube.*



Solution:—Let μ be the amplification factor of the tube and R_p its plate impedance. Let $X_{c1}=\frac{1}{2\pi fc_1}=\frac{1}{\omega c}$

By Kirchhoff's laws:

$$I_0(R_3+Z_1)+I_2Z_1-I_3R_3=E$$

$$I_0Z_1+I_2(R_p+Z_2+Z_1)=\mu Z_{c3}I_3$$

$$I_3(R_3+R_4+Z_{c3})=R_3I_0$$

$$\text{Where } Z_1=\frac{-jX_{c1}R_1}{R_1-jX_{c1}}$$

By conditions of problem: $I_2=0$

$$\text{Therefore } I_0Z_1=\mu Z_{c3}I_3$$

$$I_0R_3=(R_4+R_3+Z_{c3})I_3$$

$$\text{Whence: } \frac{R_3}{Z_1}=\frac{R_3+R_4+Z_{c3}}{\mu Z_{c3}}$$

$$\text{But admittance } Y_1=\frac{1}{R_1}-j\omega c_1$$

$$Y_3=-j\omega c_3$$

$$\mu R_3Y_1=(R_4+R_3+Z_{c3})Y_3$$

$$\mu R_3\left(\frac{1}{R_1}-j\omega c_1\right)=-j\omega c_3(R_3+R_4)+1$$

$$\text{Therefore } R_1=\mu R_3$$

This signifies that when grid is biased to cutoff plate current, $I_2=0$. This is condition of zero amplification.

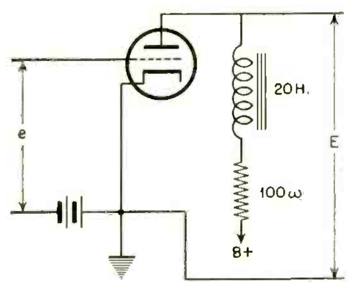
The other solution is:

$$\frac{C_1}{C_3}=\frac{1}{\mu}\left(\frac{R_4}{R_3}+1\right)$$

This solution does not disturb the d-c bias but does give zero a-c plate current.

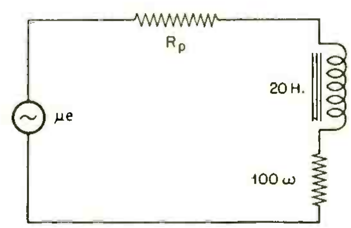
REACTANCE-COUPLED TRIODE

Problem 2:—*Calculate the voltage gain of the reactance-coupled triode audio amplifier stage shown.*



Solution:—Let $\mu=20$, let $R_p=7700$, and let the input voltage be at a frequency of 60 cycles.

The effective plate voltage generated in the tube as a result of *e* being impressed on the grid circuit is μe; and the equivalent circuit is:



Reactance of choke $=2\pi fL=2\pi\times60\times20=7550\ \omega$.

Impedance of load $=Z=\sqrt{(2\pi fL)^2+100^2}=\sqrt{7550^2+100^2}=7550\ \omega$ approx.

$$\text{Voltage gain}=\frac{\mu Z}{\sqrt{R_p^2+Z^2}}=\frac{20\times7550}{\sqrt{7700^2+7550^2}}=13.9$$

A Carrier-Current TRANSMITTER-RECEIVER

JOHN F. THURLOW, M.D., W3JRX*

Carrier-current telephone and telegraph systems have been in use many years, yet very little is written about them. Utility and power concerns have made substantial use of them, with complete privacy, since radio's early days. Considering this fact, it is surprising that the technic of transmitting radio-frequency signals over wires has been known only to those who built and maintained the equipment for these companies. However, now that the amateurs not already in government services are concerned about "what to do for the duration", an opportunity is presented to learn about what carrier-current systems can be made to do over ordinary house lighting circuits.

Wired wireless systems have the peculiar advantage of being non radiating. Present-day warfare forbids the use of radiated signals when there is danger of air attack, which is precisely the time that flexible communication systems are most needed. While the apparatus to be described here does not solve any of the perplexing problems of civilian defense, at least it is useable for short-distance communication without endangering the community in which it is used. In this connection, however, wired wireless is being studied for what usefulness it might be expected to yield in civilian defense, and developments may be forthcoming in the near future.

Advantages of System

Communication by means of carrier current has, in addition to being non-radiating, a number of other advantages. Distances up to several thousand feet can be covered with an input power of less than two watts with the intervening lines above ground. The transmitters and receivers necessary are entirely conventional and very simple to build and operate. With carrier-current equipment antennas are not necessary, which of course makes it much more convenient to move from place to place than radiating equipment. In fact, if the transmitter and receiver are built into one physical unit, only one piece of apparatus, save for the telephone handset, need be carried about. To set it into operation the line cord is plugged into the nearest socket. Such simplicity of operation will be found a restful change by those who dislike encumbrances and fussing.

The unit to be described in this article resulted from a long standing curiosity as to how carrier-current systems performed, and was built to serve a need for house-to-shack communication. The equipment was worked out by trial and error methods which finally brought results, although not until much effort had been expended winding large coils with various amounts of very fine wire. Spare parts were used when available. It will be noticed in referring to the circuit diagram that r-f chokes are omitted; no use was found for any. We used variable condensers from old battery operated (A-K) receivers for our receiving section.

In designing the transmitter-receiver unit it was decided to use 185 kc so as not to interfere with other services. After considerable listening on this and neighboring frequencies there did not seem to be any possibility that interference would be created, nor were any other carrier-current signals heard in our locality at any time during several months of almost daily operation. There is, however, a possibility that signals lower or higher in frequency might conceivably give trouble, so it is suggested that the neighborhood of 185 kc be used. The use of 175 kc for wired wireless telegraphy has been suggested elsewhere.

When development of the unit had progressed to the point where signals could be transmitted through the power lines, it became apparent that operation of the equipment could be made very simple. The transmitter, it was found, would work nicely without frequency or other tuning adjustment; the receiver required a tuning adjustment, and regeneration and volume controls. This made it possible to construct apparatus which anyone of ordinary ability could operate, and gave a minimum of opportunity for failure when operation was carried on by anyone unfamiliar with transmitting equipment.

Description of Equipment

As finally worked out, the carrier-current apparatus took the form of a "talk-back". To call the other party, a small permanent magnet speaker is used, which in conversation is switched off, putting the tele-

*1834 Burke St., S.E., Washington, D.C.

phone handset and its microphone in operation. To transmit, a "push-to-talk" switch, *SW1*, is depressed, which puts the transmitter into operation as long as it is held down. On letting the switch up the receiver again operates. The "transmit-receive", or push-to-talk switch is so arranged that the antenna condenser shifts from one part of the unit to the other in switching, along with the plate-voltage supply. This helps to prevent trapping the transmitter signal in the receiver circuits. The receiver can be left alone once it has been adjusted. As a result, no adjustments are necessary except for occasionally reversing the line plug for best signals if the unit is carried from one place to another.

Four tubes are used. The ac-dc power supply employs a 1-V rectifier which supplies both the transmitter and receiver. The transmitter consists of one tube only—a 6D6—which is suppressor-modulated by a carbon microphone through an ordinary microphone transformer, *T1*. The receiver uses a 6F7 and a 25A6G, the former tube functioning as two separate tubes. The receiver circuit is the familiar "detector and two-step" arrangement.

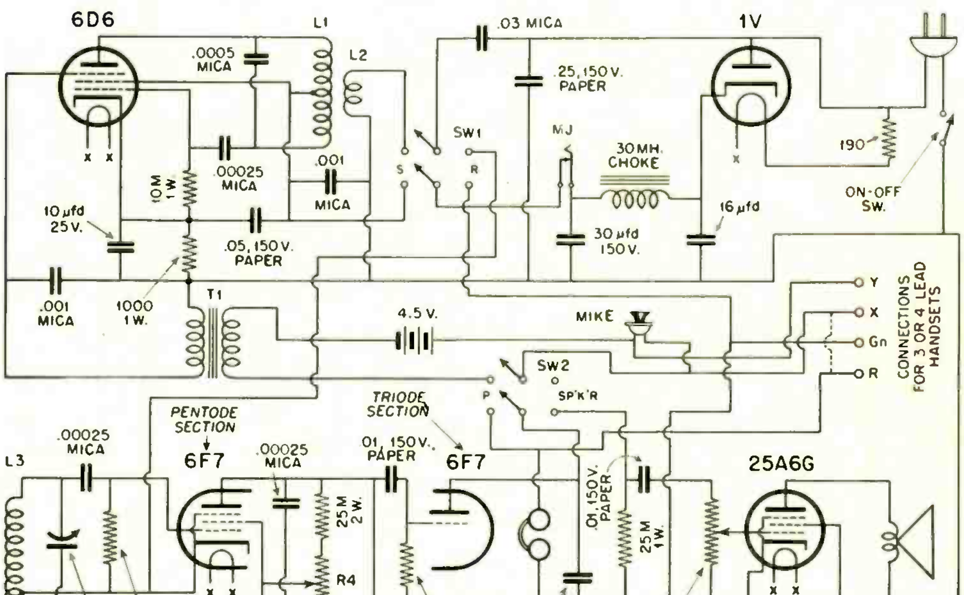
The transmitter section uses a modified Colpitts circuit, and its efficiency was found to be of a high order if the L/C ratio was kept high. When we tried lowering the oscillator frequency by adding capacity across the tank, the output fell off rapidly. The output of the 6D6 is very effectively modulated through the suppressor grid if a microphone battery of 4½ volts is used. A dry-cell "C" battery fills the bill. Less than this is not recommended. The frequency of the transmitter is fixed, and can only be changed by the substitution of another value of fixed condenser, which we did not find to be necessary. However, it is worthwhile to determine the frequency. This we accomplished by borrowing the use of a Chanalyst. It was found to be 185 kc with the values of inductance and capacity given.

The pentode section of the 6F7 serves as a regenerative detector, while its triode section supplies audio for the handset and the output 25A6G. In our equipment the triode section of the 6F7 worked into a low-impedance handset much better than into a good quality high-impedance telephone receiver. For this reason, provision was made for the use of a three terminal handset, which is the most readily available low-impedance equipment for the average amateur. However, a four terminal handset can also be used. If the handset has three terminals, connect *X* and *R* together, as indicated by the dotted line in the schematic.

The power supply furnishes about 110 volts for the plates of the oscillator and output tubes if the line voltage is about 120 volts. The amount of resistance used to drop the line voltage to the 43 volts necessary for the tube heaters is dependent on the prevailing line voltage in a given location. As ours averaged 128 volts, we used 210 ohms at *R10* to prevent heater voltages from getting too high. In other locations it is possible that as little as 190 ohms will be required. Considerable filtering was necessary, and blocking condensers across the line were put in which effectively reduced line noises from electrical devices.

CIRCUIT OF CARRIER-CURRENT TRANSMITTER-RECEIVER

L1—405 turns No. 32 E.W. on 1⅜" dia. form (3¾" winding) center-tapped. L2—13 turns No. 32 E.W. over center of L1, separated by 3 layers of paper. L3—460 turns No. 32 E.W. on 2¼" form (4¼" of winding) tapped 20 turns from bottom. SW1 is Centralab 3-position spring return switch. Use middle and lower positions. SW2 is the same type. Use two positions, as above.



Constructional Notes

Construction offered no problems once the manifold terminals of the 6F7 were firmly in mind. Nothing was grounded to the chassis, so as to reduce the likelihood of receiving shocks. To reduce chances of radiation, the oscillator tube and inductances, and as much of the r-f circuits as possible were covered by a shield can which also served to protect the fine No. 32 wire used in the inductances from damage. The inductances were wound on cardboard cylinders and painted with coil dope. The fine leads from these were brought to terminal strips bolted to the chassis in order to make the necessary connections with fixed condensers, etc., and to give the r-f section physical stability.

The mechanical layout used can be that which seems most practical. Breadboard construction was found to be just as satisfactory in performance as the metal chassis arrangement which we eventually used. A panel of insulating material, such as Presdwood or Masonite, is suggested with a view to making it possible to mount panel circuit components so that they will be isolated from the chassis. If every effort is made to prevent the chassis from being "ground," there is little likelihood of shocks being felt, which could easily happen if the polarity was such that the chassis was "hot." Even so, operation in the bathtub or from wet cement flooring is not recommended.

Operation

To operate the equipment, the line cord is plugged in and reversed if necessary so that a singing line hum, instead of a low 60-cycle buzz, is heard. The regeneration control *R4* is advanced until it just goes into the fringe of oscillation, as in any regenerative receiver. When two of these units are plugged in, the push-to-talk switch of one is held down until its signal can be tuned in by the other. The tuning adjustment of the receiver need not be changed once it has been made at a sufficient distance to tune it accurately. With the microphone connected (handset in operation, and speaker inoperative), the push-to-talk switch is depressed and the other unit called. This other unit then responds with its switches in the same position, while the first listens by simply letting the push-to-talk switch return to the receive position. With a little practice conversation is effected quite smoothly.

CW operation, of course, is simply a matter of plugging a key into the meter jack *MJ* and keying the plate lead of the oscillator, with the other unit in oscillating condition to heterodyne the signal. With the receiver in this condition, radiated long-wave signals will often be heard across the receiver dial.

Within one building the signals received from the other unit are broad, and so strong that the plate current fluctuates in the receiver. With the units farther apart, tuning becomes sharper and more normal. It is recommended that they first be tried between buildings several hundred feet apart once "percolation" has been achieved.

Long, uninterrupted power lines strung above ground provide the best medium for distant operation, and when circumstances are favorable good signals are heard at about 3000 feet. When the intervening lines are unfavorable, which seems to be the case with underground conduit, or when transformers provided with baffles intervene, the dx possibilities are much less. It is well to remember, also, that two locations only a block apart may have a separation of a mile or more from the standpoint of the power lines supplying them, so that a study of power routing may prevent disappointment by indicating that what seems a short distance is really dx.

Our limited experience with this form of communication has seemed to indicate that low power offers results comparable to what a similarly-powered transceiver would provide under somewhat unfavorable conditions. The outstanding feature, however, is the convenience of the equipment from the standpoint of operation and portability. A single piece of equipment which may be easily carried about can be made to yield many useful functions about the house, or from building to building, and its usefulness is not decreased by the need for adjustment or special installation. For example, one of our relatives has called her OM from a neighbor's house to remind him to feed the baby.

Legality

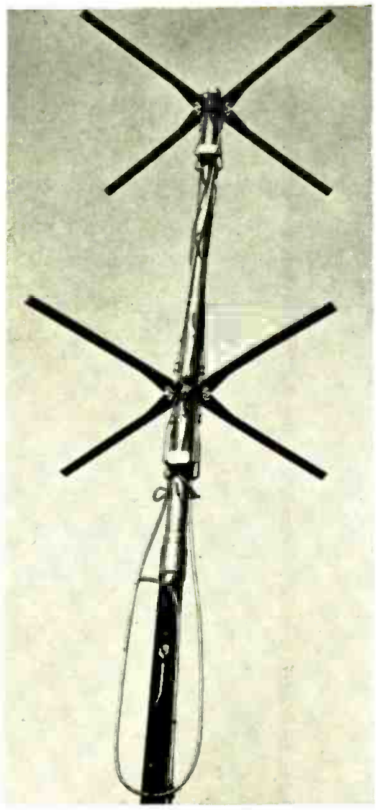
The Federal Communications Commission took cognizance of the use of wired wireless systems by unlicensed persons when the matter of collegiate "broadcasting" between university buildings was brought to its attention. It was decided by the Commission that the "Provisions Governing the Operation of Low Power Radio Frequency Devices" was applicable. In other words, the rules laid down for wireless record players and the "Mystery Control," which permit operation if the field strength of the device does not exceed 15 microvolts per meter at a distance of $\lambda/2\pi$ from the transmitter, were allowed to apply in the case of wired wireless telephony.

The University students in question were stated to have used an input power of 2 watts. The FCC not only allowed the inter-dormitory systems to continue in operation, but those who developed them are now aiding the OCD in its attempts to find a way to utilize wired wireless for air-raid warning purposes. It is strongly urged, therefore, that the precedent of using inputs of 2 watts or less be rigidly adhered to in order to prevent the enactment of prohibitive legislation. This will surely follow any excesses of power or frequency deviation, especially those which cause interference with other services. It is also essential that the equipment be checked for radiation with a long-wave receiver before being put into use. If care is exercised, the amateur will have a new instrument to use "for the duration" and after.

The Story of W51R's New

SKY RIGGING

◀ Here is the photo-story on the assembling and raising of the turnstile antenna for W51R, Stromberg's f-m station at Rochester, N.Y. The yarn starts at the bottom of the page and works up to the completed installation shown at the right. The unit includes a sleet melter that furnishes heat to each element when the outside temperature stands between 28 and 30 degrees.



▲ STAGE 4

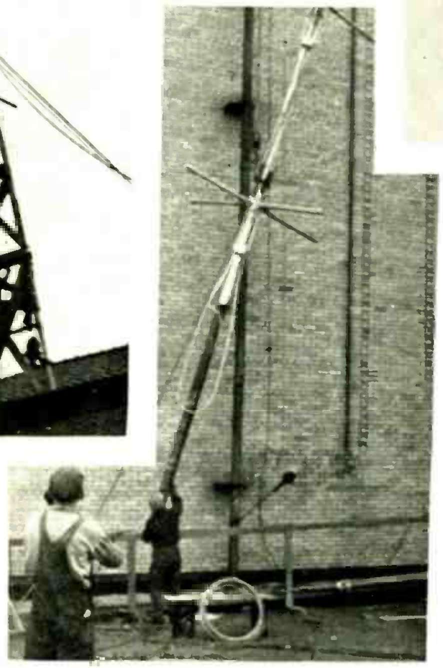
Here she is, all up and working. The main coaxial feeder can be seen coming up from below and splitting at the "T". The two bays are stacked, one above the other, at a distance of one-half wavelength. In this manner corresponding doublets can be made to operate in phase. The bays are fed in such a manner that adjoining elements operate 90 degrees out of phase. This out-of-phase operation gives the radiated pattern a circular characteristic. The long loop of coaxial line turning from the "T" is a half-wave loop which is used to feed opposite elements of the various doublets 180 degrees out of phase.

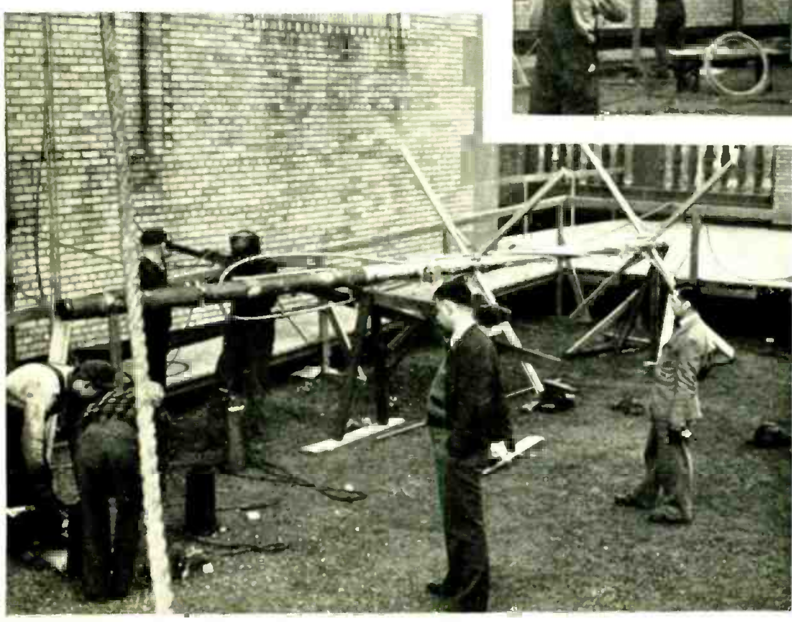
Almost in place, the top-section is shown as it was rolled and tugged into position so that the welders could "hemstitch" her into place. The ⅜-inch coaxial line dangles below.

STAGE 3 ▶

All ground work (12 stories up) the antenna now heads for its perch. The riggers have purposely hooked onto the shaft slightly off center to help in controlling the swing of the assembly on the way up.

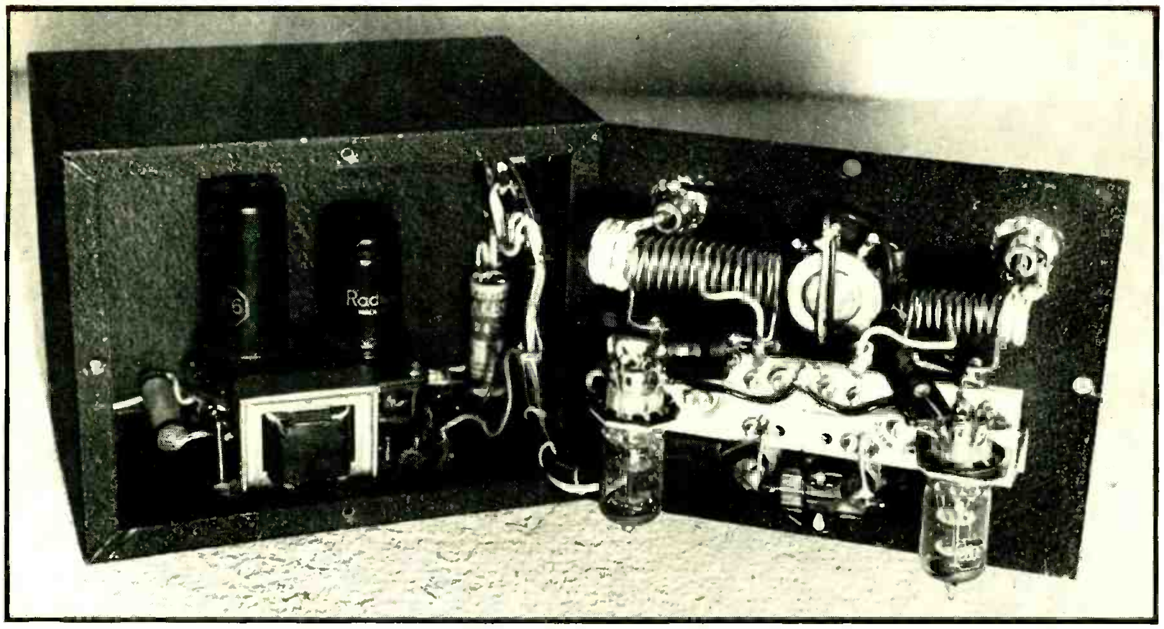
STAGE 2 ▶





◀ STAGE 1

Here is W51R's new two-bay turnstile antenna as riggers assembled it for hoisting. The two kibitzers are Alex Gressens and Ken Gardner of the engineering staff. Note that the elements have been bolted to the main shaft and the coaxial line installed.



The completed receiver, exploded view, showing how the panel may be opened out for antenna adjustments. Note slack in cabled leads to permit opening. Trouble shooting is easy without removing set from car.

Mobile, Dual-Channel

UHF DEFENSE RECEIVER

L. W. MAY, Jr., W5AJG*

◀ A mobile receiver was needed for a certain defense guard organization. The requirements were not at all difficult to any practicing uhf amateur. As a matter of fact, they appeared just too modest, considering the complexity of equipment the average uhf ham had been "tinkering" with before the *second* shut-down.

Requirements

The requirements were these: *1.* To be used in conjunction with a 1.7-mc regular police set-up. At once, this made available the plate and filament voltages from the police receiver. *2.* To tune two communication channels. For all practical purposes, these will be called "56" and "112" mc. *3.* Instant change from one to the other channel. *4.* Freedom from ignition noise. *5.* Inexpensive and easily installed and operated. *6.* To cover a radius of a *few* miles.

Not a rough ticket at all. Forget about your much desired Orbital-Beam Secondary-Electron Multiplier Tubes and such, of which nobody seems to be carrying a spare in his pocket. Instead, relive your uhf days of five or six years ago. The "good ole days" when radio seemed simple enough and the average blockhead thought he understood a few things about uhf, plus me.

Only item number *6* occasioned even the slightest hesitancy. Most uhf men have had lots of questions put, but "How many miles can I work?" seems to be one of the most popular (and dangerous). In this particular case, further investigation revealed little over which to be concerned. The associated mobile transmitters for the two channels were approximately ten watts each, which was reasonable assurance that a simple receiver would easily suffice. Furthermore, I don't wish to appear even more completely to have "blown my top," but modulated oscillators at the lower of the two frequencies are still being issued in certain quarters. However, do not become alarmed. There are reasons—

The super-regen, of course, is the answer. It admirably fulfills all qualifications, even including that

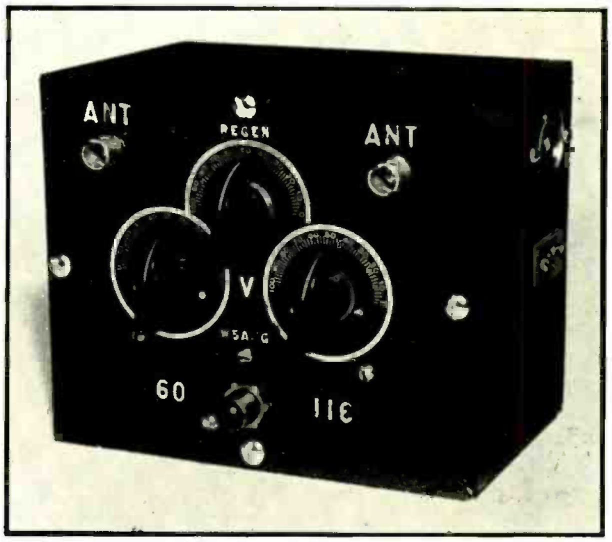
*R4, 9428 Hobart St., Dallas, Texas

of expenditure. Can you tie that? From daily reading of the rags, one would think expenditure was of inconsequential magnitude. Perhaps this commanding officer is a bit old fashioned . . .

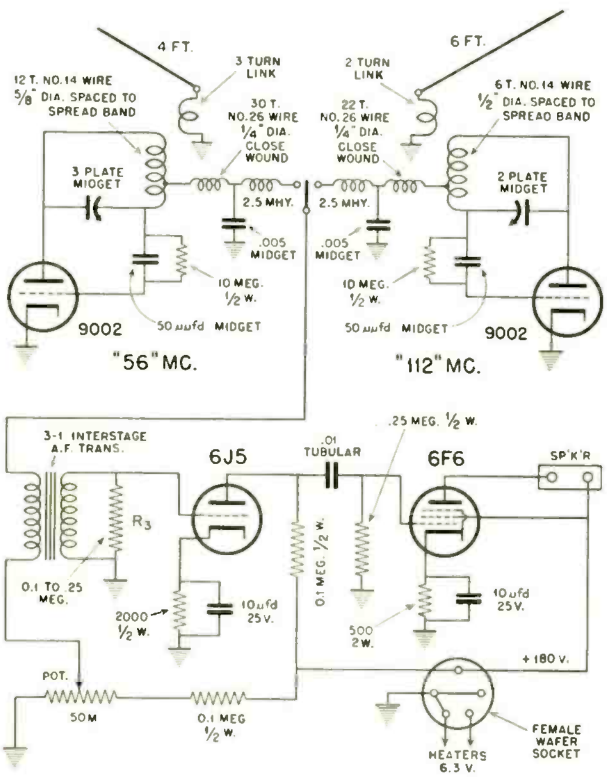
The newer 9000 series tubes, of which the 9002 is a triode, are excellent oscillators at these frequencies. The difference in cost, compared with, say, a type 6J5, was felt justified. Good action is to be had on much lower plate voltage and radiation from the receiver somewhat attenuated. The number of cars along with geographical location in this case, resulted in negligible complaints from this cause. Furthermore, the two separate communication channels, if used correctly, practically guarantee nearly complete relief from the receiver radiation problem.

Design of Receiver

Nothing at all new is incorporated; just ordinary ham gear caliber. Don't forget—plenty of lock washers, as with any mobile equipment. These things get the daylights shaken out of them. Two r-f sections are used, one on "56" mc and the other on "112" mc. Both use 9002 tubes. A single-pole-double-throw toggle switch is inserted in the lead to the interstage audio transformer to provide selection of the oscillators. This transformer then excites a 6J5 first audio tube, which is resistance coupled into a 6V6 output stage. A regeneration control is provided, but no volume control. In a moving car, one usually wants about all the volume he can get anyway, so it is left off, and incidentally is not missed at all. The resistor *R3* is merely adjusted for proper level and left alone.



Front view of receiver. Band switch at bottom, with the "56" and "112" tuning controls directly above. The regeneration control in the middle serves for both channels. Antenna receptacles are at top of panel. Power and speaker sockets are on side of cabinet.



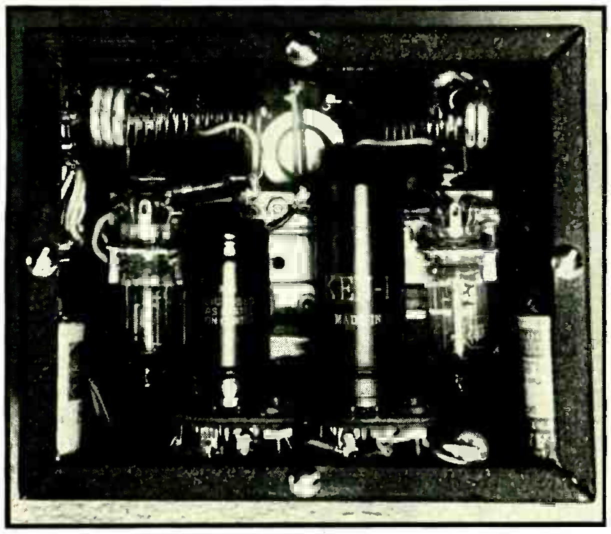
Complete schematic diagram of the dual-channel receiver. All parts values and coil data are given. Instant switching from "56" to "112" mc, or vice versa, is accomplished by one single pole double throw switch. This tacks plate voltage onto the 9002 in use.

The innards are contained in a small box six inches wide, five inches high, and four inches deep—a standard item on the market. This is usually bolted to the steering column or to the dash. No mounting is shown in the photograph as all cars require different types of "head scratching."

Two antenna receptacles are provided, one for each frequency. The band-selecting toggle switch is mounted in the middle of the panel at the lower edge. When it is pointed to the left, everything on that side of the panel is to do with "56" mc. When in the right position, "112" mc is brought into play. It is impossible to have both oscillators pumping at the same time, due to the plate voltage being broken by the selector toggle switch. This has to be—or it could probably be used as an air-raid warning device.

The front panel of the box is detachable and attached to it are all r-f components. Some play is left in the cabled leads, so as to allow it to be pulled a few inches away, which makes for convenient adjustments to the antenna coupling and so on. The audio transformer and associated tubes and parts are permanently tied down inside the box. No adjustments are necessary here, and placement is of no great importance.

Filament and plate potential are introduced through the five-prong wafer socket. As above stated, this power is borrowed from the regular low-frequency police receiver. Speaker terminals are provided just below the five-prong socket and a small p-m speaker with matching transformer mounted wherever is convenient.



Rear view of set, with front panel in place. Tank and antenna coils are seen at top, with upside-down 9002's just below.

No trouble should be encountered with this unit. The 56 and 112-mc bands are still around, although they are not overburdened with QRM, I am told. Nevertheless, locating them is still fairly simple. The receiver performs very smoothly on both communication channels and good results are obtained using total antenna lengths (including lead-in, which should be as short as is practicable) of four feet for 56 mc and six feet for 112 mc. Using these lengths on whip antennas provides for low-impedance terminations at the antenna coupling link, which may consist of a few turns coupled to the tank circuits of the oscillators. One side of the link is grounded to the antenna receptacles.

Double-Channel Advantage

Locations and contour of terrain influence greatly maximum distances obtainable when talking car to car. It has been found wise not to prognosticate too heavily in this regard. Open flat country on the one hand and metropolitan areas on the other tend to confuse most uninformed uniformed personnel, as far as dx is concerned. Of course, elevated, stationary control centers are able to communicate with mobiles for quite respectable distances, with the lower of the two frequency channels perhaps at an advantage. With the use of the double communication channels, it is possible to "do things" that one channel could not attempt—rather like the airways with their well-known "North" and "South" frequencies, etc. This phase will not be further elucidated. Leave that to the dispatchers and such. We are supposed to talk about the means.

No further constructional details are necessary here. The photographs are much better salespeople, coupled with the fact that all this is mere revival of equipment forgotten years ago, for most of you uhf men. The possible exception is the new 9002 triode. It is really a honey at 112 mc and above. Miss Acorn, watch your laurels.

TELEVISION AND AIR-WARDEN INSTRUCTION

Lieutenant William F. Maley, (right) of the staff of the Coordinator for Police Department Civilian Defense, New York City, gives the oral instruction in the televised lesson for air wardens on putting out a fire bomb. Assistants at the left demonstrated various devices to be used. These lessons were broadcast over NBC's television station WNBT to groups of air wardens stationed at points throughout the city where television receivers were made available.

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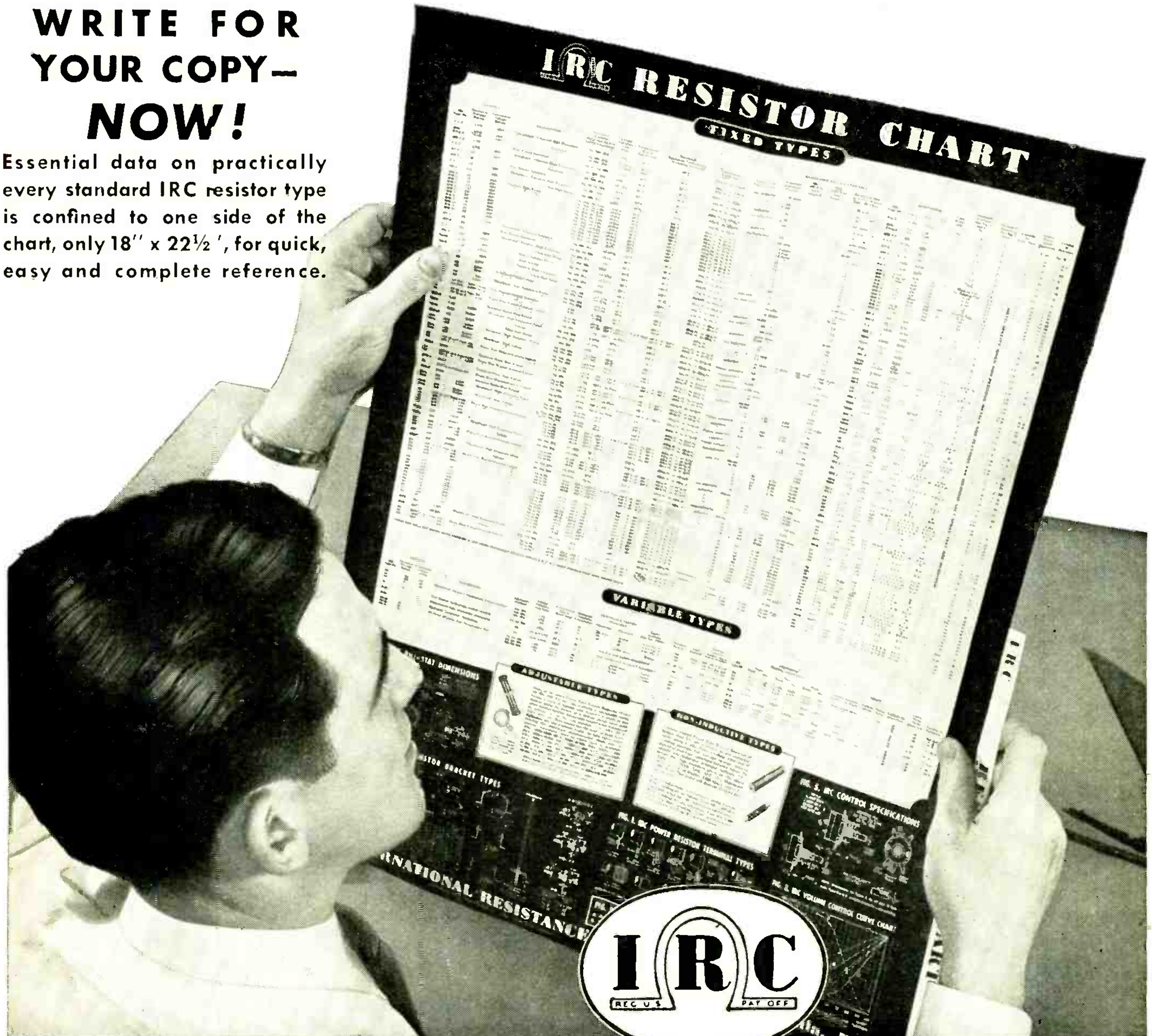

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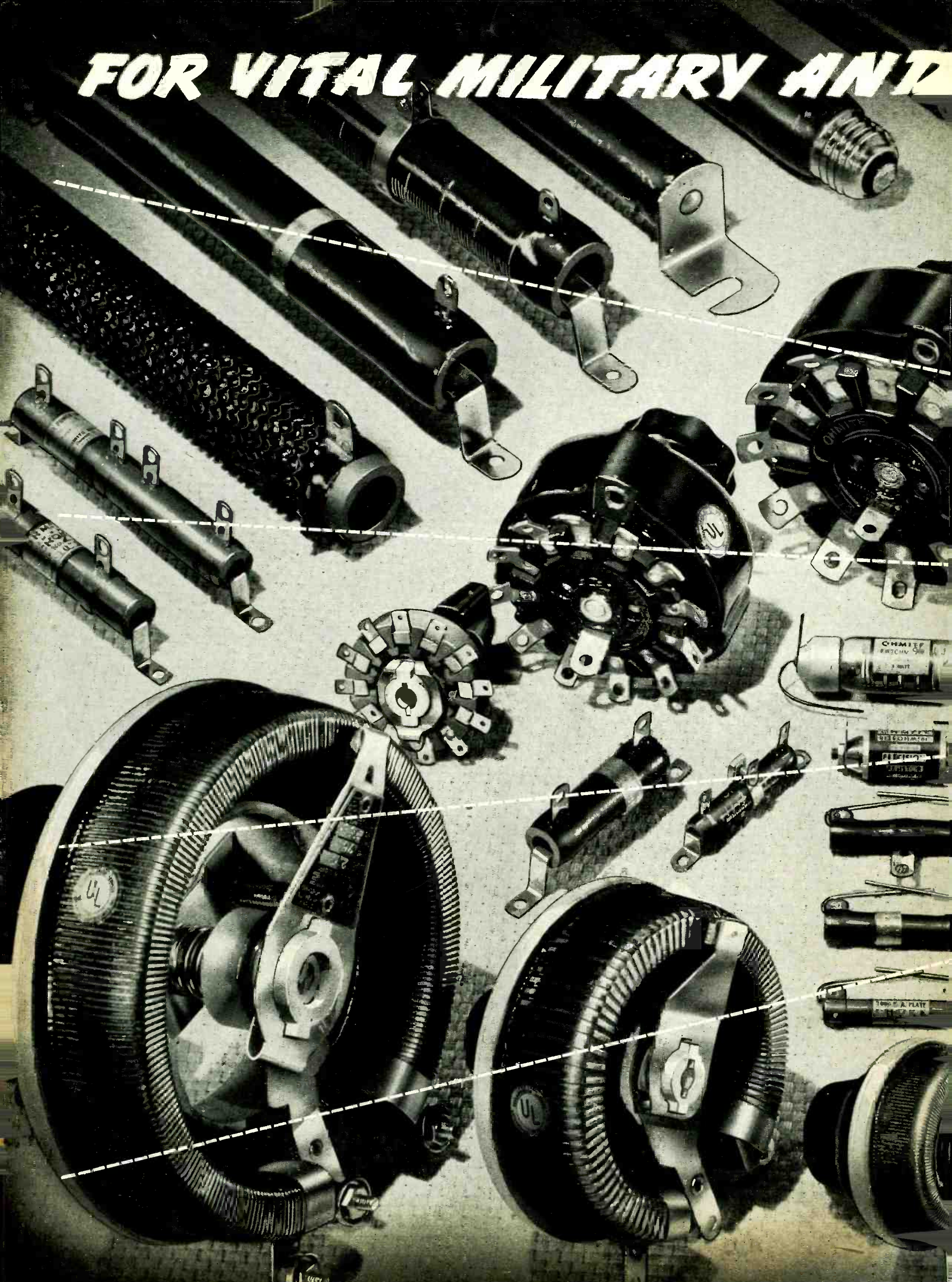
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Proposed Ultra-High-Frequency Navigational Aids

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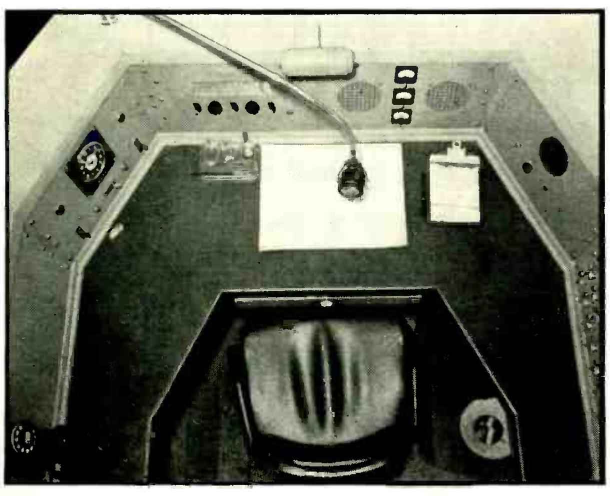
WQNK's NEW CONTROL CONSOLE

◀ J. W. Councill, of Police Radio WQNK, City of Norfolk, Va., has sent us the accompanying photo of their new Control Console, which should prove of inspiration to others.



The console panels from left to right are: first, an alarm system from vital industries and business houses, the indicator lights still to be installed. Next is the control panel, from which either the main or emergency transmitter may be selected, power applied and all antenna and associated relays changed over. This operation is controlled by a single switch. The panel also includes an electric clock, and manual "on air" and calling tone switches.

The third panel carries a Howard all-wave receiver used to monitor other police frequencies. The next panel includes the speaker for the Howard, an inter-office communicator, and meters and switches for the termination of the remote receiver lines.

The fifth panel is a Kaar receiver for emergency reception from mobile units; and the last panel carries the indicator lamps for the mobile units, giving the dispatcher a quick check on them.

The mike is a Turner dynamic on an adjustable boom. The transmitter is normally controlled by a foot switch.

New Products

LOW-FREQUENCY LINEAR-TIME-BASE GENERATOR

For those oscillographic studies requiring sweep frequencies as low as one cycle every few seconds, a Low-Frequency Linear-Time-Base Generator is now announced by Allen B.

Du Mont Laboratories, Inc., of Passaic, N. J. Used in conjunction with an oscillograph provided with a long persistence cathode-ray tube, or with photographic recording methods, this accessory instrument opens up new fields of investigation of low-frequency transient and recurrent phenomena. Vibration studies, stress and strain measurements, low-frequency electrical observation, electrocardiography and electroencephalography, are all facilitated by this new unit. The frequency range of the instrument corresponds to rotating speeds of 12 to 7500 r.p.m., thus permitting the use of an oscillograph for the visual study of certain characteristics of rotating machinery at low and medium speeds. Transient observation is provided for by a single-stroke sweep circuit.

The Du Mont Type 215 Low-Frequency Linear-Time-Base Generator provides a sweep frequency range of 0.2 to 125 cycles per second. The maximum undistorted output signal is approximately 450 volts peak-to-peak, balanced to ground. The single sweep is initiated either manually or by observed signal. Excellent linearity is assured by a compensating circuit.

Thoroughly portable, the instrument measures 14¼" h., 8-13/16" w., 19½" d., and weighs 41 lbs. Steel cabinet, black wrinkle finish, with carrying handle. Etched metal black panel. 115 or 230-v. a.c. r.m.s. 40-60 cycle. Power consumption, 50 watts. 1 amp. fuse protection. The primary voltage is selected by a switch in the instrument.

★

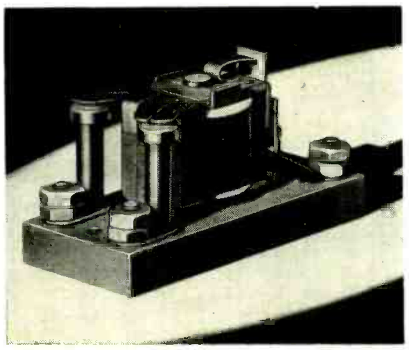
LIGHTWEIGHT AIRCRAFT RELAY

A sturdy, lightweight relay designed particularly for aircraft applications calling for operation at high altitudes under severe vibration conditions has been announced by the industrial control division of the General Electric Company. The relay is also applicable to tank installations.

Designated CR2791-A100A, the relay weighs only 4½ ounces, is 3⅛ in. long, 1⅝ in. high, and 1⅜ in. wide, and can be mounted in any position. It is designed for mechanical frequencies of 5 to 55 cycles per second at 1/32-inch maximum amplitude (1/16-inch total travel) in any direction. Altitudes from sea level to 40,000 feet and ambient temperature ranging from -40 C to 93½ C fall within the performance scope of the relay.

The CR2791-A100A relay has a current rating of 25 amps at 12 or 24 volts. The coil operates at 1.2 watts. The single-pole, normally open contacts are designed to stay open when the coil is not energized and closed when the coil is energized at rated voltage even when subjected to linear acceleration of 10 times gravity (10G) in any direction, or to the vibration conditions outlined above.

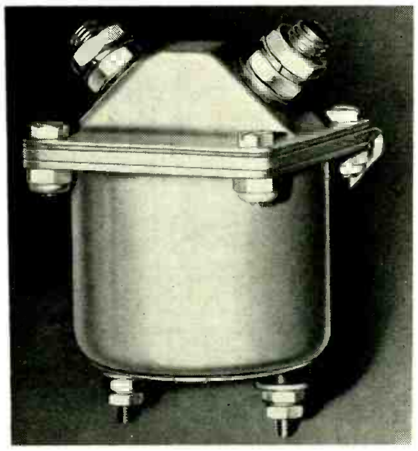
The entire relay has been built to meet United States Army Air Corps specifications. It is corrosion proof, having passed, among other rigid tests, the Navy's 200-hour salt-spray test. Its balanced-armature construction contributes to its excellent vibration performance.



★

NEW DYNAMOTOR CONTACTOR

A new contactor specially designed to start and stop dynamotors used with aircraft equipment has been announced by the industrial control division of the General Electric Company. It is available for either 12- or 24-volt direct-current circuits, and conforms to the general requirements set up for aircraft control devices. The contactor is also applicable to tank installations.



The dynamotor contactor is approximately 2½ in. wide and 4 in. high, weighs only 2.3 pounds, and can be mounted in any position. It is totally enclosed, with the contacts in the upper compartment and the coil and plunger in the lower compartment. Copper-lead-alloy contact tips are used to assure the best high-current inrush performance.

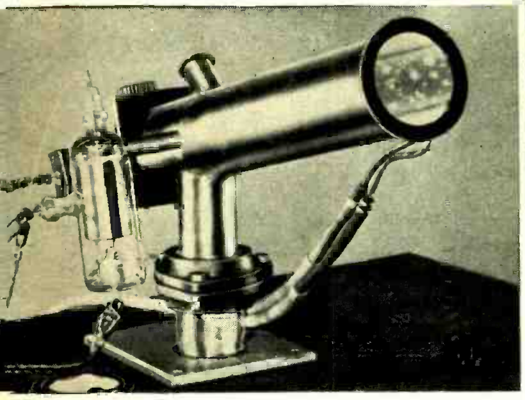
The contactor meets Signal Corps vibration requirements, being good for mechanical frequencies of 5 to 55 cycles per second at a maximum of 1/32-inch amplitude (1/16-inch total travel) applied in any direction. The single-pole, normally open contacts are designed to stay open when the coil is not energized, and closed when the coil is energized even when the contactor is subjected to a linear acceleration of 10 times gravity (10G) applied in any direction, or to the vibration conditions outlined above.

All ferrous parts of the contactor are treated to resist corrosion. Non-

(*Continued on page* 59)

Filament Emission

Makes the Modern World Go Around



Close observation of the flow of electrons from a heated filament is made possible with this Electron Microscope. This instrument, designed and constructed in the Eimac laboratories, virtually gives a motion picture projection of the electron movement.

Before filaments are sealed into the triode they are placed in a temporary vacuum where they undergo their first emission test. Thus faulty filaments may be weeded out without further processing.

THE life of radio communications hangs by a tiny thread of filament wire. If the steady flow of electrons from the vacuum tube filaments ceases, the transmitter is off the air no matter how excellent the other components may be performing. To assure peak emission under the most severe operation conditions, many exacting tests are conducted during the process of manufacture.

Above is an Eimac technician checking an Eimac tube on the Peak Emission Tester. This device, designed and constructed in the Eimac laboratories, measures the flow of electrons emitted from the completed tube. Of a long series of filament tests conducted at various stages of manufacture, this test is the final. Other important controls are illustrated at left.

From beginning to end, Eimac tubes are designed and constructed to give vastly superior performance. The proof that they do is made clear by the fact that Eimac tubes enjoy first choice in the minds of leading radio engineers throughout the world.

EIMAC 304T

Filament Voltage	5 or 10 volts
Plate Voltage (D.C.)	3000 volts
Plate Dissipation	300 watts
Power Output 3000 volts at 75% eff.	900 watts

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U.H.F. . .

[*Continued from Page 25*]

find mentioned elsewhere in this column that FM is developing in excess of all expectations, and if you are a careful reader you will note that already there aren't enough FM channels to go around. Again, it shouldn't be necessary to emphasize that the radio spectrum is a very, very limited place, and while for the past two years the gang has not quite wasted the 56-mc band, 2000 or 3000 idle kilocycles will certainly present a most attractive picture when this mess is over, unless we can keep abreast of technical developments.

"Well," you say, "what's the matter with you; there's a censorship on!" Yes, of course, but did you ever try building a hot front end receiver using pipes and the 9000 series and strictly for FM use? Did you ever try series tuning in your mixer circuits for greater conversion efficiencies? Probably not.

Just a suggestion, fellows; load up those pipes for the FM broadcast band while there are still a few parts left and a place to use them.

Miscellany

Mel Wilson took a half hour off to drop us a line about propagation and wave theory and such. Mel suggests a better word for the sporadic E mass, besides cloud, while emphasizing the three-dimensional picture necessary for correct approach on assuming 56 wave paths. One other point raised was the difficulty in obtaining data for the coming summer. May we urge all reports on sporadic E when affecting the FM stations be forwarded to us, and we'll act as a clearing house for that important data. All letters and cards will be acknowledged.

Jim Brannin of 6OVK writes that the radio blackout caught the Tucson boys just 2 days after they got authorization for their OCD set-up. Some sort of periodical activity is hoped for as about 18 units have been built so far. Jim's modified superinfra is, at writing, doing 24 hour duty at the Sheriff's office, as it replaced an S-27 that broke down. The superinfra does a swell job at pulling in the 112,150 kc sig from the State Police relay station atop a nearby mountain.

6SLO, 6KMM, 6PCB, 6OZM, 6OWX and 6OVK saw a demonstration of light-beam communication at the University of Arizona, and all were evidently so intrigued that work has been going on using this system, and some very interesting results are promised in the near future.

A little concern was raised by several parties regarding a question that appeared in our February column, on page 63, dealing with u.h.f. propagation characteristics and possibilities. Some comments were pretty sharp and to the point, but all expressed a natural concern. To those who wrote in, be it known that the questioner supplied sufficient references to allay any thought of "fifth column activities," and we will go so far as to state that the party was connected with a most friendly foreign government. To cease all worries, you will generally find the questions answered are but portions of questions we have completely covered by previous direct mail.

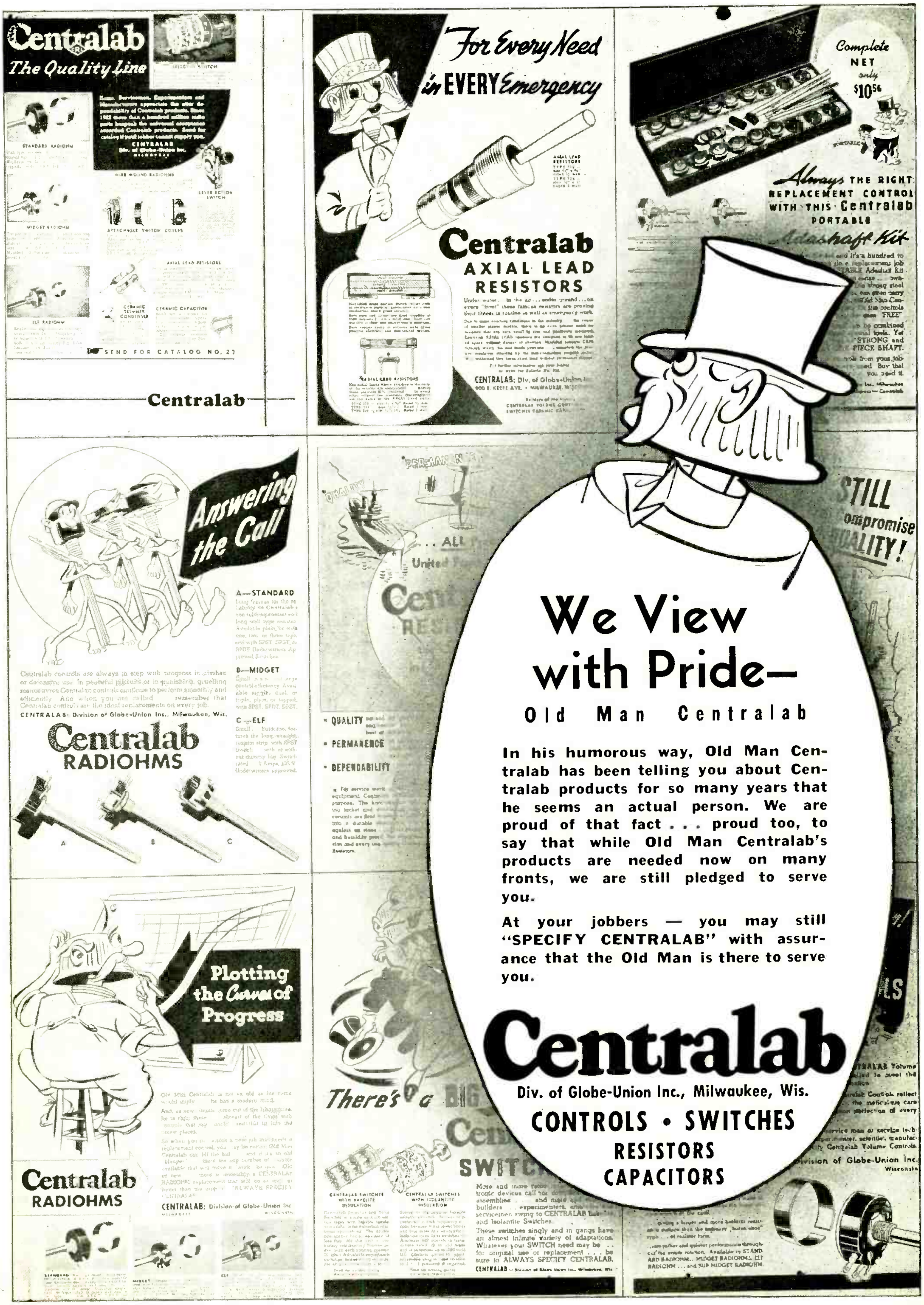
Clyde, 6QLZ, Criswell, says he has nothing left but three small transceivers and the receiving equipment—Clyde's station being located on a very unique portion of property. He furthers his suggestion on the co-axial coupling in the February issue, page 35, with a note about using it on p-p stages, by tapping the 3-30 condenser directly into the center of the coil. This particular coupling may be a little tricky to tune till you get the hang of it, as it will bring the noise up to a sharp peak. Clyde wonders if everyone has the experience of co-axial antennas being very poor on reception and at the same time giving an omni-directional 6 db gain on transmit? W1HDQ and W2AMJ also have reported similar results, while we find a "whirling Joe" always outperforming any e.d.z. on 112 mc. The whirling Joe, to those unfamiliar with it, is the co-axial vertical with 4 quarter-wave ground-plane arms.

We are still getting reports on the November 28th sporadic E session. Seems that this day was the best for short skip signals during the past two years, believe it or not. As was pointed out previously, double hop was taking place, while 6QLZ says it was the first time in 8 years of DX-ing that sporadic E signals were heard 500 miles away on frequencies over 60 mc. KOKO, out in Honolulu, was coming through around 53 mc. on a harmonic, while W5HTZ still says he heard a Spanish station call CQ around 57.17 mc. According to more reports over the entire mid-Atlantic section and New England States, the FM station W45BR came through with a terrific signal for over three hours, while 56 was open, but dead.

Portable Stuff

W9BKM and W6QLZ say this (ex-) portable stuff isn't as easy as it sounds and cite a little incident. Seems that 6QLZ had started down the mountain only to punch a nice size hole in his gas tank on a sharp rock and had to plug it up with his Sunday-go-to-meeting shirt. Meanwhile 9BKM, over on Signal Peak, parked his car in the woods and took the portable rig up into the fire tower, only to come back and find someone had chopped down a huge pine tree which had fallen right square across the car. Back to 6QLZ, who found the road so rough that he lost muffler, front fender and bumpers.

Van R. Field, fresh from Lear Avia and now with F. M. Link, says these super-regens on 112 mc radiate a lot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At your jobbers — you may still "SPECIFY CENTRALAB" with assurance that the Old Man is there to serve you.
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CONTROLS • SWITCHES
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CAPACITORS

more than anyone thinks. Last summer while mobile sailboat in Long Island Sound his 7A4 with about 90 volts on the detector was picked up 11 miles away by W2ADW. Van does considerable experimenting with super-regens. having also models with 955's, HY615's and a 9002. The latter tube seems to be about the best for stable operation and sensitivity with low rush level. The squeal on the 9002 is also way below any of the other types.

FM Swing-Around

FM continues to roll merrily along its way. The FCC stoppage on all new work appears not to affect FM commercially as much as it might at first seem. Reports are at hand stating that there are quite a few low-power FM transmitters complete and ready for shipment. and there are quite a few more phase-shift modulators of the wide-band characteristic suitable for broadcast purposes.

A real, but somewhat seemingly unnecessary, bottleneck has developed in the product of antennas. since many of the stations applying are disinclined to build their own. Turnstiles seem to be the prevalent polarization and John E. Lingo, leading manufacturer of turnstiles, advises, " . . . we are unable to quote on FM turnstiles at the present time inasmuch as our entire plant is operating on emergency work for the Government; and then, too, most of the material used in the manufacturing processes are under strict priority control . . . we can supply in a reasonable length of time on an A-1-a rating."

New Rigs

E. H. Clark, of W49D, writes they will shortly have their RCA FM 10-A in operation and will then start building their version of a 45-kw final. An eight-section turnstile has been erected atop the Eaton Tower Building (365 feet) in downtown Detroit. . . . W45V has a Lingo product of 6 bays 330 feet above the heart of Evansville, Indiana. They are using about 8000 watts for an 8397 square mile service area. . . . Unless some unforeseen difficulty pops up, W53PH will have their 10-kw final in operation by this time, according to Frank Gunther of R.E.L., who are supplying their equipment. W53PH has a 4-bay turnstile right underneath old William Penn's hat across the street from the Philadelphia City Hall. . . . While talking about Philly, W49PH is about ready to get on regularly. They will use a co-axial vertical some 350 feet above Chestnut Street. . . . Meanwhile W57PH went on the first part of April. Their transmitter was heard testing from the RCA plant, and was one of the last to come off the line. A make-shift antenna will probably have to suffice for the duration and to ensure some degree of coverage, vertical polarization will probably be used.

It isn't quite fair at this time, in case you have already noted, to jump to the conclusion that everyone will use horizontal polarization. In fact, this time, eight vertically-polarized stations are, or will soon be in scheduled operation.

W51C seems to be doing pretty good at full power of 50 kw. Don't forget, FM stations are licensed for service areas, and power is in reality a secondary factor. The Zenith Chicago antenna is a 4-bay turnstile with a power gain of 2.9, a little low as turnstiles go. . . . W75P, Pittsburgh, was lined up to start on or about March 20th. Pittsburgh is already represented by W47P, on the air 10 hours a day. . . . Another mountain-top station, W41MM, started a wide-spread promotional campaign, which you probably saw if you live in Virginia. North or South Carolina, Tennessee, Kentucky, Georgia or Alabama. They will start out with 3 kw around the last of April. . . . Up in Boston town W67B, the commercial version of W1XK, will probably start testing from out of Hull, Massachusetts way, by the middle of April.

T. R. Dunlop, of WJJD and W47C, says they have no indication when equipment will arrive so they can begin tests; the project may be dropped if those conditions persist. . . . Experimental W8XFM of the Crosley Corporation is off the air for the duration and no attempt will be made to build a commercial outlet. . . . W55M finally got all the pieces for their 50-kw transmitter, located at Richwood, Wisconsin, and got on the air February 22nd. This power reaches out to over 1,500,000 more listeners in that area.

H. D. Taylor, of WTIC, says they just got their co-axial cable in time and just got enough steel to make a 302-foot tower. A 6-bay turnstile is in the offing which will remove one of the consistent 1-kw vertically polarized signals. Operation has probably begun by this time. . . . W45D is running at 13.5 kw at latest advices; maybe they find their 50 kw too hot to handle.

Way out west, K53LA of the Standard Broadcasting Co., in Los Angeles, are getting their feet wet with a 1000-watt job and a temporary antenna, which is located on Lookout Mountain. . . . K45LA seem to be in daily operation and are in fact increasing both power and service area considerably. . . . W81PH of the Seaboard Radio Broadcasting Corporation will probably show up on 46.50 mc, because of the high antenna location contracted for. . . . K31LA, the Los Angeles C.B.S. outlet up on Mt. Wilson, will probably be the biggest station in the West for a long time. A service area of 34,000 square miles with a population of something like 3,500,000 is planned.

Notes

FCC seems to be somewhat sorry because of the war and the stop sig-

nal on newspaper-controlled FM stations. Undoubtedly the loss in the rapid development at that critical moment is felt now. FM stations aren't easy to follow when flying a beam and many times FM stations are located far outside the cities they cover, so it would appear when the broadcast band stations shut down during an "alert," nothing could stop the restricted coverage of the FM fellows.

FM is serving excellently afield. Too bad it couldn't serve excellently at home with an all-out for FM broadcasting. At last count 29 permits were still pending on the newspaper inquiry.

Two FM grants for Jersey City on 91 and 95 cleared up that problem, or so it seems. The three frequencies left for the New York area, Jersey City also covering New York City, are being fought for by nine concerns at the last count. . . . Columbia University, home of the "Major," now rebroadcasts W2XMN and W71NY in their wired radio system within the College grounds. W65H also advise they have made a listing of their programs available to Yale, Wesleyan and Connecticut Universities. The idea is to create a restful background and musical programs for the poor students to study by and relax with.

Noise Limiters

[*Continued from Page* 28]

Of the series or balanced shunt limiters, there is little choice between the two as far as noise limitation is concerned. The series limiter does, however, have the advantages of gain, selectivity, and ease of construction over the balanced shunt limiter, with perhaps the exception of the modified diagram of *Fig. 2C*. This modified limiter, as explained, does not produce limitation comparable to other types, and finds application where only a moderate degree of noise reduction is desired. For the two automatic series limiters shown, the one of *Fig. 3B* will produce the best results when using a high-gain audio amplifier. *Fig. 3C* is somewhat simpler and may be used with low-gain amplifiers in which a small amount of diode biasing is not objectionable.

Undelayed avc voltage may be obtained satisfactorily from most of these circuits by connecting the avc line to the bottom of the i-f transformer. In *Fig. 2B*, slightly better results may be obtained by tapping it to the plate of the limiter bias diode. With *Fig. 3C*, if avc bias is taken from the bottom of the i-f transformer, the voltage will be reduced by 2/3 over that obtainable in the other circuits because of the voltage divider action of *R3*, *R4*, and *R5*.

It is the opinion of the writer that since an automatic noise limiter is so easily built into a receiver, it should not be omitted from any receiver which is to be used on the higher frequencies. A noise limiter will often mean the difference between no reception at all and satisfactory reception when ignition-noise interference is a limiting factor. Also, its noise-reducing action while tuning between stations should not be overlooked, as this advantage might be equally well applied to broadcast receivers.

"Bell Labs"

[*Continued from Page* 11]

men as well as methods and ideas from the research organization to the operating departments. In other words, many men engaged originally as research investigators have gone ultimately into the manufacturing and operating departments in positions where their special skill has been of vast advantage to these departments. Where such transfers have been made they have almost invariably resulted in a rapid indoctrination in the departments of an appreciation of the power of the so-called scientific method as distinguished from cut-and-try

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methods in the solution of new problems or in the elimination of unexpected difficulties.

From Management down the Laboratories are imbued with a traditional New England culture, with perhaps a responsibility to society as its principal motivating force. Certainly, in the absence of a purely commercial incentive, something of this character gives spirit to the workers. And coupled to this is a permissiveness of the culture to a free expression of a worker's ideals.

Management itself is composed of men of science brought up under this tradition—men trained over years to the knowledge that skill and foresight and liberal-mindedness are the prime requisites in an organization devoted to the maintenance, improvement and extension of a service essential to over 130 million people.

John Mills has said that skilled management always strives not only for technical advancement of the art but also for human relations between all the individuals concerned with the business. Without successful management, and its farsighted planning, progress is haphazard and accidental.

Project Research

Another important factor in the success of the Laboratories is the "project method" of research wherein the aim is established and pinned down to a comparatively narrow channel of investigation. As John Mills has put it, "The adoption of a project permits a unified and coordinated research program; it adds direction, prevents scattering of effort and rolls up ideas, methods, techniques and results with a cumulative effect like that of compound interest. The research grows and branches like a tree, with new shoots and budding problems springing from the last season's growth. Its roots meanwhile reach farther and farther back into the fundamentals of the sciences upon which it depends, entering new ground, tapping new veins of knowledge and venturing into a dark unknown."

It was out of the project method that came the important physical discovery by Dr. C. J. Davisson that a stream of electrons is diffracted by a crystal as if they were a beam of waves; and the investigation into the factors underlying textile insulation and the resulting discovery that proper washing of cotton would make it an insulator superior to ordinary silk. The apparatus required for that investigation was relatively simple, the ingenuity considerable, and the ultimate financial savings large.

From the research projects have emerged many by-products purely incidental to the investigations. From his researches in speech and hearing, Dr. Harvey Fletcher developed the artificial larnyx. In the analysis of speech, the research investigators set themselves the task of picking up telephonically all the component sounds of speech and of converting them faithfully into corresponding components of current. They planned, in other words, to construct devices so perfect that even the keenest ear could not find a flaw in their rendition; and then, by controlling the current through electrical filters or other circuit elements, to introduce measured amounts of imperfection until an observer could just detect a fault. In that way they expected to reach a quantitative understanding of the importance of the various component sounds of speech. These investigations necessarily carried somewhat into the field of music, where they produced important information. The clear knowledge of the nature of sound that was derived from these studies, which have been continued ever since, has been an important factor in the improvement in the quality of telephone conversations; and it has been the basis of the enormous advances which have been made in public-address systems and in the related fields of phonographic reproduction of

[*Continued on Page* 58]

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THE EDITORS OF RADIO
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music, of sound motion pictures, and of radio broadcasting.

Motivation is usually keener when effort can be centered on some definite project. The growth of research is then a more or less natural evolution, guided somewhat, perhaps, by pinching off inopportune buds or refusing to give financial nourishment to shoots which do not promise rapid and firm growth.

Analogy

In the research department properties of materials are sometimes effectively explored through mechanical analogs. For instance, a model developed for the study of hysteresis has been found useful in fundamental research in the theory of magnetic and microphonic action.

As an instance of the value of such analogs, and as another example of a by-product of research, in 1924 the Laboratories' development of equipment for electrically cutting phonograph records and for reproducing from them had reached a point where it was obvious that electrically-cut records were suitable for commercial use. The resulting process of recording was licensed early in 1925 to Victor and Columbia.

At that time there was some feeling by those concerned with phonograph sales that the public would be unwilling to buy electric reproducing equipment. A purely mechanical, or acoustic, phonograph was then developed and licensed to Victor. This device, which was called the "Orthophonic" phonograph, represented the result of the application to the problems of mechanical vibration of the electrical techniques which had been developed during the study of transmitters, receivers, and telephone lines.

Though the problems of the Laboratories are perhaps not the problems of industrial research laboratories in competitive fields, there appear to be here many methods of operation that would prove advantageous in any research setup. The war effort accents the need for a more thorough coordination of activities in all fields.

—M. L. MUHLEMAN.

Lunar Effect

[*Continued from Page* 19]

new moon rays are not detected at all times, but only at periods of sunspot activity and when the moon itself is approaching the optimum position in the heavens; i.e., if there should happen to be a particularly active sunspot group about two days before the full moon, the E layer ionization at night would rise notably. As the moon becomes full the lunar energy begins to decrease until two days before the last quarter, when it has its least effect.

There may be some significance to psychologists and physicians in this discovery from the viewpoint of the moon ray's hitherto unaccounted-for influence upon the human being.

Editorial Comment:

Undoubtedly there is much more to the lunar effects than have been heretofore supposed. It is recalled that some ten years ago, V. S. Forbes, Christ's College, Cambridge, published a paper through the Smithsonian Institution dealing with "The Moon and Radioactivity".

Forbes concluded, to everyone's amazement, that actually we don't know where the craters and markings on the moon's surface came from. Anyone who has studied the surface features of our satellite is immediately impressed by the remarkable sharpness and freshness that most of these features exhibit. Yet there exist on that body several of the most powerful destructive forces known to man.

The first of these is the differential contraction and expansion of the rock surface due to the abruptness of the thermal ranges, from that of absolute zero of inter-solar space to the tripled boiling heat of the sun's rays. This force should operate a steady erosion so that if the surface were subject to temperature changes every 14 days since pre-Archeozoic times, would surely have degraded all the moon's features to a very marked extent. If the craters were of volcanic origin, surely the presence of atmospheric gases would have aided this slow degradation, although the atmosphere, itself, may have been lost ages ago.

The second force is the one even more likely to obliterate the sharp relief of the moon's surface. It is the continuous never ending bombardment by meteors and meteorites. Certainly, the moon deprived of its gaseous envelope as a means of protection, these meteoric bodies would slowly hammer the features to a more even surface.

In such a way the Forbes paper continued to dissolve every known answer to the question of the formation of the moon's features.

Since we assume that the moon was once part and parcel of the earth, we can see from our geological structure that the moon is composed almost entirely of sial, the light acidic rock of pronounced radioactive content.

Forbes' paper then branched into the formation of the surface features by the theory of radioactive heat. This volcanic heat, deep below the surface, would cause a gradual shifting and retain the sharpness of the moon's craters to a very high degree.

We can now see that a moon's surface of partially radioactive material is perhaps not too far wrong. Stetson's hpyothesis, if anything, tends to support Forbes.

New Products

[*Continued from Page* 48]

ferrous parts are likewise treated except where such treatment would interfere with operation. The contactor is suitable for use in ambient temperature ranging from 60 C to minus 40 C.

The contact rating is 50 amperes on an 8-hour basis. Inrush current rating is 500 amperes at 32 volts direct current. Coil wattage is 9.5.

★

PLASTIC ELECTROLYTICS

Specially designed, inverted type tubular capacitors with lock nut now available in modern plastics for chassis top installation. Available in single or multiple units over a wide range of capacities and working voltages in both electrolytic and paper by-pass types, to meet rigid government specifications.

They are jar and vibration proof with effective insulation from chassis to container—providing an ample safety factor for voltage surges. Specially developed insulated leads cannot ground. Additional information may be had by writing American Condenser Corp., 2508 S. Michigan Ave., Chicago, Ill.

★

LATCH-IN, ELECTRICAL RESET RELAY

A new mechanical latch-in, electrical reset relay especially designed for aviation purposes and carefully tested to withstand vibration incident to such service has been announced by Struthers Dunn, Inc., 1335 Cherry Street, Philadelphia, Penna. Known as Dunco Relay Type CX3190, this unit operates from a brief impulse without the necessity of keeping the coils energized. Double-pole, double-throw contacts are rated at 6 amperes at 12 or 24 volts, d.c. An auxiliary contact breaks one coil circuit. All contacts are insulated from the frame for radio frequency. Coils are for operation on d.c. only. Dimensions of the unit are 3-5/16" high x 1¾" wide x 1⅜" deep. Weight is 7 ounces. Other contact arrangements are also available.

Dunco Aviation Relay and Solenoid Bulletin No. P-249 describing Type CX3190 as well as various other units for aviation uses will gladly be sent upon request to the manufacturer. It is suggested that those also interested in other Dunco Relay and Timer types for industrial and general use also ask for the complete Dunco Catalog.

★

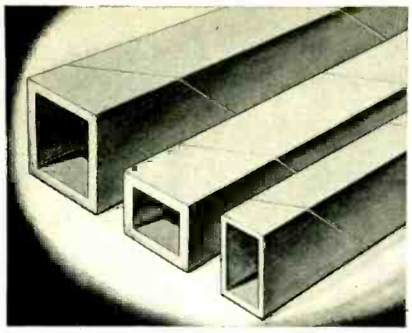
NEW PROCESS ADDS STRENGTH, ACCURACY, SPACE-SAVING TO PRECISION TUBES

Another improvement in tubes for electric coils is announced by Precision Paper Tube Co., 2033 W. Charleston St., Chicago, Ill.

Heavy compression insuring a new degree of strength, and resistance to collapse—clean perfect formation—finer accuracy in sizing to specifications, superior dielectric properties, lower moisture absorption rate, space-saving on "light jobs," absolutely square corners and straight side walls are among the advantages claimed for tubes treated by this added process.

The improved tubes are preliminarily formed as heretofore, of dielectric kraft, or fish paper, or a combination of both. The paper is spirally wound on a steel die in an automatic machine. The tube is then pushed pneumatically through the new heated compression die which effects an added compression of about 10% and finishes the operation.

Precision Tubes made by this process can be supplied in round, oval, square or rectangular cross section and in continuous lengths of any wall thickness with any inside or outside diameter.



The advance in the approach to absolute accuracy is especially worthy of note. It has been shown that Precision Tubes made by this process can be held to a tolerance of .002 inches.

★

SHATTER-PROOF ALL-METAL RHEOSTATS

A new type of IRC All-Metal Rheostat for aircraft and ordnance use where durability to withstand bomb and gunfire concussions, as well as dependability to meet conditions of high humidity and other temperature extremes are prime essentials, has been announced by the International Resistance Company, 401 N. Broad St., Philadelphia, Pa.

Actually, the new units entail only minor changes from the rugged yet light weight metal construction which has characterized IRC Rheostats in the past. Instead of ceramic insulators which might shatter under concussions, the new ordnance type units have bakelite insulators. In addition to being lighter in weight than conventional rheostats, the IRC All-Metal Rheostats have a 50% lower temperature rise for equal size in other types and are available in both 25- and 50-watt sizes to meet the 200-hour salt-spray test requirement. Covers are available to protect the units from dust and dirt.

Blue prints showing dimensions of the ordnance types as well as IRC Rheostat Data Bulletins Nos. VI and VI-a describing the standard types will gladly be sent upon request to the manufacturer.

★

AIR RAID ALARM

An alert signal unit of small dimensions, and designed for installation in any type radio receiver without altering the circuit, is now being marketed by the National Union Radio Corp., 57 State St., Newark, N.J.

Known as Model AR-101, the air raid alarm has but four connections to be made. When installed, and the receiver is tuned to any desired local station, the unit gives out a loud siren-like tone at the instant the station carrier goes off the air—an indication of an impending raid.

Since the siren tone is generated in the alarm unit, the receiver to which it is attached may be left on during the night with the volume control turned all the way down. When the alarm sounds, it may be turned off by means of a toggle switch provided for that purpose.

For further information write National Union at the above address.

★

Remember Pearl Harbor
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IMPROVING STABILITY OF FIXED-FREQUENCY RECEIVERS

WILLIAM S. GRENFELL,* W7GE

◀ Some time ago the writer was confronted with a problem the solution of which was so simple it left that "why didn't I think of it before" feeling.

The trouble occurred in connection with a remote receiver installation which was used on the 1706-kc State Police frequency. After the system had been in use for a few days it was discovered that the drift in the receiver, which was left running continuously, was so great that many weak signals were lost entirely. The receiver was a fairly well known communications type superhetrodyne which included 1706 kc on the broadcast band tuning range.

It was determined that the drift was due to the change of temperature, throughout the day and night, in the building which housed the receiver. It was while considering such solutions as a crystal oscillator control, temperature compensating condensers, etc., that the easy way out was found. By merely connecting an additional variable condenser across the oscillator section of the condenser gang and tuning the oscillator to the *low* frequency side of 1706 kc, a marked improvement in oscillator stability was achieved. In fact the improvement was so great that it was quite feasable to use the crystal filter, setting it fairly sharp, where before weak signal reception was impossible with the crystal cut out and selectivity switch in the "broad" position.

The reason for using the "B.C." band position rather than the next higher band, which also included 1706, was that the sensitivity was noticeably greater due to the low capacity of the tuning gang (higher circuit Q) at that frequency. This, of course, was also the reason for the instability of the oscillator.

The writer hopes that this kink will be of use to others who desire an improvement in fixed-frequency reception without the additional expense and trouble of going to crystal control.

*Route 7, Box 818-B, Portland, Ore.

LOOSE TALK SINKS SHIPS

A Simplified Method of Checking Power-Transformer Design

LLOYD W. ROOT, W9HA

As time goes on the more effective utilization of available materials will take on increasing importance, particularly as regards copper and iron for power transformer construction. In RADIO for March, 1941, and again in February, 1942, the subject of proper transformer design for optimum utilization of available core material is quite thoroughly presented.

Disadvantages in the methods suggested for experimentally checking design data are apparent, however; in one case requiring specialized instruments not generally available, and, in the other, tedious effort and possible waste of precious wire. A simple experimental method has been worked out by the author which makes possible design checking on either commercially manufactured units or others of the home-built type.

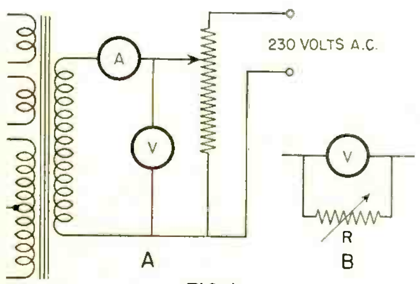

FIG. 1

Setup for simplified method of checking power-transformer design. A low-range a-c voltmeter may be used, as at B, if a shunt is used.

Simplified Method

Using a potentiometer capable of handling an ampere or two of current or an auto-transformer of the "Varitran" or "Variac" types in conjunction with an a-c voltmeter of 250 volts range and an a-c ammeter having a range up to one or two amperes, the job is easily done.

Fig. 1-A shows the necessary setup for the test. If a low-range a-c ammeter is not available, a low-range a-c voltmeter may be shunted by a resistor *R* of 5 to 10 ohms, as shown in *Fig. 1-B*, and used as a current indicator. As an example, an iron-vane type of a-c voltmeter reading 3 volts full scale was shunted with approximately 4 ohms to read full scale on one ampere. For lower or higher current ranges, of course, the shunting resistor can be increased or decreased in value. Since measurements of current strength are comparative only, it is not necessary to know exact values of a-c being measured. Voltage indications on a shunted meter used in this fashion must be subtracted from the potential indicated by voltmeter *V* in *Fig. 1-A* to give the actual voltage being applied to the primary of the transformer under test. All secondary windings are left disconnected from any usual loads so that the core saturation point only is determined. Any shorted turns on either primary or secondary will show up immediately by excessive energizing current values. Normal excitation current should not exceed a few tenths of an ampere, even for power transformers rated at a few hundred watts.

Recording Data

In recording the data it might be advisable, if using a shunted voltmeter as ammeter, to use a high-resistance shunt

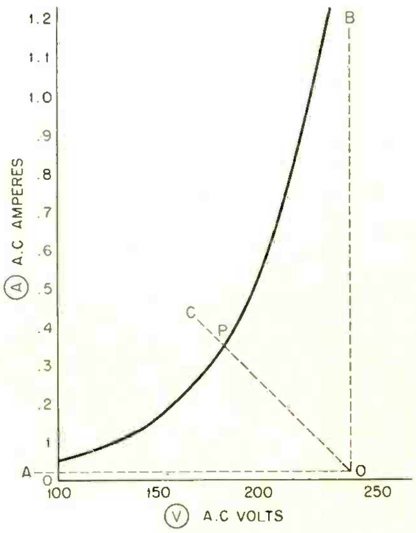

FIG. 2

for low applied potentials and then, while the ammeter reads full-scale, decrease the value of the shunt so as to make the meter read one-tenth as much, thus providing for larger applied currents for the upper portion of the curves shown in *Figs. 2* and *3*.

When testing a transformer, in which the number of turns on the primary is unknown, a simple graph of input volts vs. amperes is plotted, as shown in *Fig. 2*. For transformers whose total primary turns is known, each applied voltage may be divided into the number of turns, this giving turns-per-volt, T/V, in each instance.

After carefully plotting the observed data it will be seen that the extreme ends of the hyperbolic curves appear to become asymptotic or parallel to two imaginary lines *A0* and *B0* which are mutually perpendicular. These lines may be drawn in on the graph and a third line, *0C*, drawn at an angle of 45° with *A0* or *B0*. From the point of intersection of line *0C* with the curve at point *P*, a line dropped down to the horizontal axis will indicate the proper primary operating potential in *Fig. 2* or the proper turns-per-volt point in *Fig. 3*.

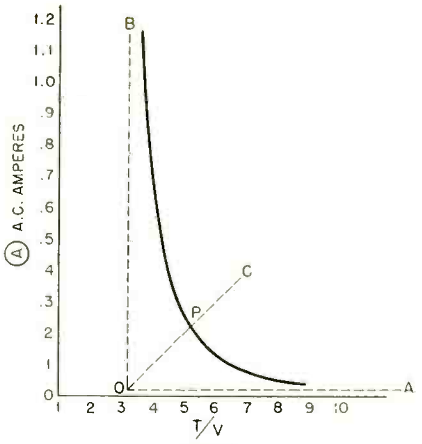

FIG. 3

Curve which determines proper turns per volt. Fig. 2, on page 61, indicates proper operating potential.

Working Example

For a certain transformer, whose curves are shown, the primary was wound with 840 turns of wire and it was designed to operate on a 120-volt line. From *Fig. 2* the proper operating potential would be 180 volts and from *Fig. 3*, the proper turns-per-volt would be approximately 5.3 instead of the 7 turns per volt with which it was wound. A considerable saving in space could therefore be obtained, making possible either the use of a greater cross-sectional conductor for the windings, resulting in a transformer capable of handling greater power, or a larger number of secondary turns could be used for higher output voltages. The operation of transformers at the determined optimum point results in core flux densities of from 65 to 70 thousand lines per square inch, which value could thus be used in initial computation of proper design for future construction.

DATA ON ELECTRONIC GADGETEERING

Recognizing the fact that radio amateur activities are being seriously curtailed for the duration of the war, so far as communications are concerned, Aerovox engineers are compiling and already releasing practical data on electronic gadgeteering as a promising outlet for the equipment, skill and ambition of the radio amateur. Articles on radio control circuits and the industrial applications of electronic devices are currently appearing in the monthly *Aerovox Research Worker*. Copies will be sent to anyone writing Aerovox Corporation, New Bedford, Mass. Also, a free subscription may be obtained by getting the endorsement of any Aerovox jobber.

TWO NEW RADIO TEST DEVICES DEVELOPED BY UNITED AIR LINES

Two new devices for testing aircraft radio equipment have been designed and produced by United Air Lines for use in service shops along its routes.

One of the devices, designed by H. N. Wilcox of the laboratory staff, is a vibration generator for testing radio equipment under conditions considerably in excess of those encountered in flight. An air-operated generating unit with an electrical frequency control is connected with a test table which can be rotated through 360 degrees for inspection of equipment during test. A means is provided for increasing or decreasing the amplitude of vibration, with a maximum intensity of 3 g's for a 100-pound load. The frequency of vibra-

Push-button r-f signal generator with 24 crystal-controlled frequencies, used for aligning of all aircraft receivers carried aboard United Air Lines Mainliners. E. A. Jensen, the designer, is pictured.

tion is constant at 30 cycles per second.

The other device, designed by E. A. Jensen, also of the laboratory staff, is a signal generator for aligning and measuring the frequencies of all radio receivers carried aboard United's Mainliners. The equipment is made for the operation of 24 crystal-controlled frequencies but can be adapted to as many as 40. It has an output ranging from one millionth of a volt to one volt and is capable of modulation up to 100 percent at six different audio frequencies.

★

Book Review

A.R.R.L. "DEFENSE" HANDBOOK

THE RADIO AMATEUR'S HANDBOOK, Special Defense Edition *(1942), by the Headquarters Staff of the A.R.R.L. A manual for radio training courses. Published by the American Radio Relay League, Inc., West Hartford, Conn. 288 pages, including 8-page topical index. More than 500 illustrations, charts and tables. Price, paper bound, $1.00, postpaid.*

Designed to replace the League's standard Handbook in defense radio training courses, this special edition retains everything from the regular edition that is useful to the task in hand and has added new chapters on mathematics, measuring equipment and code instruction. It omits such sections as those on construction of amateur equipment and operation of amateur stations.

The nine basic theoretical chapters of the standard edition are retained intact. Brand-new is the first chapter covering the elementary mathematics necessary for the solution of all formulas and interpretation of graphs appearing throughout the text. This includes a review of decimals, method of extracting square root, algebraic notation and manipulation of formulas, laws of exponents, logarithms, a discussion of linear, power and exponential functions and their application to graphs, and the use of polar coordinates. Supplementing this chapter, a four-place log table is included in the Appendix.

The constructional chapters of the regular edition have been condensed into one new chapter in which representative types of radio equipment are featured. Data on and photographs of the more generally used commercial receivers and transmitters are included, along with selected equipment described in the regular edition. Similar treatment has been given the chapter on measurements.

There is a new chapter on learning the radio telegraphic code. Its treatment is based on up-to-date methods of learning by hearing, and is believed unique in its handling of the subject.

Changes of Address

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by the 25th of this month

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Address labels are shipped to our mailers on that date. Remember: under U.S. postal laws, magazines sent to an old address are junked unless forwarding postage has been left in advance with the postmaster; unlike letters and cards, magazines are not forwarded either free or collect (except to addresses in the same city).

Circulation Department

It can be used either for self-instruction or for the guidance of those interested in giving code classes, for whom suggestions for the construction of special code-instruction tables for large groups are included.

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A.S.T.M. STANDARDS ON ELECTRICAL INSULATING MATERIALS

The latest edition of this annual publication is considerably enlarged by the inclusion of new specifications and tests and several reports and papers. It provides in their latest form as of December, 1941, the some 58 specifications and tests issued by A.S.T.M. covering this field. Outstanding activities carried on by A.S.T.M. Committee D-9 on Electrical Insulating Materials are covered in certain reports, one on punching quality of laminated phenolic sheet; a study of measurements of power factor and dielectric constant at ultra-high frequencies; a report on round-robin tests of power factor and dielectric constant for glass; and several discussions on the significance of tests of insulating materials, including dielectric strength.

Seven of the specifications and tests cover insulating varnishes, lacquers and their products and thirteen provide standardized test methods for molded materials. The section covering plates, tubes, and rods includes nine standards and there are six standards in the field of mineral oils, ceramic products and solid filling and treating compounds. Two test methods cover insulating paper; four apply to mica products; and there are eight specifications—four each for various rubber products and textile materials; and four standards give tests and tolerances for various types of glass products and for woven tapes. Six standards give tests covering arc resistance, dielectric strength, power factor and related properties and tests.

This publication, which includes for the first time a detailed index, also includes two tables of contents, one listing standards in numeric sequence. The 1941 report of Committee D-9, with its recommendations on standards, is given.

Copies of the 450-page publication can be obtained from A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, at $2.25 per copy, heavy paper cover.

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LOW-FREQUENCY LINEAR-TIME-BASE GENERATOR BULLETIN

An explicit bulletin, describing the new Du Mont Type 215 Low-Frequency Linear-Time-Base Generator and its applications, is now available on request, from Allen B. Du Mont Labs., Inc., 2 Main Ave., Passaic, N.J. This accessory is used in conjunction with a Du Mont Type 175A Cathode-Ray Oscillograph or equivalent, and

Remember Pearl Harbor
BUY U.S. WAR BONDS

permits screen studies requiring sweep frequencies as low as 1 cycle every few seconds, or more specifically, within its range of 0.2 to 125 cycles per second.

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News

UNITED NATIONS NEED HAM EQUIPMENT

Radio hams are being asked to sell their transmitters and receivers for use by the armed forces of the United Nations, according to an announcement by the American Radio Relay League, which is centralizing information on available apparatus on behalf of the government agencies concerned.

Only commercially-manufactured communications-type receivers and transmitters for which standard instruction manuals are available are required at present. Such equipment is more readily used and understood by military operators than homemade units, even though the latter may be of comparable quality, it was explained.

Urgent shortages of communications equipment required for defense needs led to the call, manufacturers finding themselves unable to make deliveries sufficient to fill the intensified demand as the theatre of war expands in widening circles.

Amateurs willing to turn over their apparatus to their country are requested to advise the ARRL at West Hartford, Conn., giving model number, condition, and the price for which it can be delivered crated to a local transportation agency. Only standard manufactured equipment should be offered, homemade or "composite" equipment not being required at present.

The biggest need is in transmitters. According to League statistics, approximately two-thirds of the receivers found in amateur stations are factory-made but only 5% of amateur transmitters were purchased from manufacturers.

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ERROR-PROOF RADIOTELEGRAPH PRINTER

All possibility of error from defective signals in radio telegraph transmission is eliminated by a new error-proof radio printer put into operation in the international communications field on the direct radio circuit of R.C.A. Communications, Inc., between New York and Buenos Aires.

Product of RCA Laboratories, the new printer automatically rejects false signals and prints an asterisk in place of an incorrect letter.

Present secrecy restrictions necessitated by the war, prevent a full description of the printer. It may be revealed, however, that the device operates with a special code so constructed that a defective character is immediately recognized as such by the printer.

The printer may operate alone or with others over the same radio transmitter. When more than one printer is used, they are operated in conjunction with RCAC's "time-division" multiplex system, which provides two, three or four simultaneous message channels over a single radio transmitter. In sending messages, the output of the several transmitter-perforators is brought together in the multiplex equipment, scrambled, and delivered to a transmitter, which beams the aggregate radio signal to its destination. At the receiving end, the multiplex equipment unscrambles the signal and delivers the components to the several separate error-proof printers. The aggregate speed of the four-channel system is 248 words a minute.

With ordinary telegraph printers as used on the radio, errors may be caused by spurious signals. The appearance of an extraneous signal, or the absence of part of the correct one, will cause printing of an incorrect letter on the ordinary instrument. Unless the error is obvious, it may go undetected.

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The Marketplace

Classified Advertising

(a) Commercial rate 10c per word, cash with order; minimum, $1.00. Capitals: 13c per word. For consecutive advertising, 15% discount for 3d, 4th, and 5th insertions; 25% thereafter. Break in continuity restores full rate. Copy may be changed as often as desired.

(b) Non-commercial rate: 5c per word, cash with order; minimum, 50c. Available only to licensed amateurs not trading for profit; our judgment as to character of advertisement must be accepted as final.

(c) Closing date (for classified forms only): 20th of month; e.g., forms for June issue, published early in June, close May 20th.

(d) No display permitted except capitals.

(e) Used, reclaimed, defective, surplus, and like material must be so described.

(f) Ads not relating to radio or radiomen are acceptable but will be grouped separately.

(g) No commissions nor further discounts allowed. No proofs, free copies, nor reprints sent.

(h) Send all Marketplace ads direct to Santa Barbara accompanied by remittance in full.

NEW SAN FRANCISCO SHORT-WAVE STATION

O. F. Walker, radio engineer of the General Electric Company, is now in San Francisco supervising the installation of a 100,000-watt short-wave transmitter, which will be another gun in a kilocyclic battery "shooting" from the United States across the Pacific in the propaganda war with Japan.

The powerful transmitter, built by General Electric and operated previously at its Schenectady station WGEO for short-wave broadcasts to Europe and Latin America, will be operated in San Francisco under call letters KWID. Operators of the station will be Associated Broadcasters, Inc., operators of long-wave station KSFO. General Electric is completing another 100,000-watt transmitter for WGEO at Schenectady and meanwhile is on the air there with two other short-wave transmitters, WGEO and WGEA.

KWID, which will have studios and offices at the Hotel Mark Hopkins, will render additional short-wave service to that now being given by General Electric's 50,000-watt San Francisco station KGEI, with studios and offices at the Fairmont Hotel. KGEI has been broadcasting to Latin America, Asia, the Antipodes, and Africa for more than three years, and is at present the only United States short-wave broadcasting station west of the Mississippi.

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RADIO OPERATORS SOUGHT FOR FEDERAL WORK

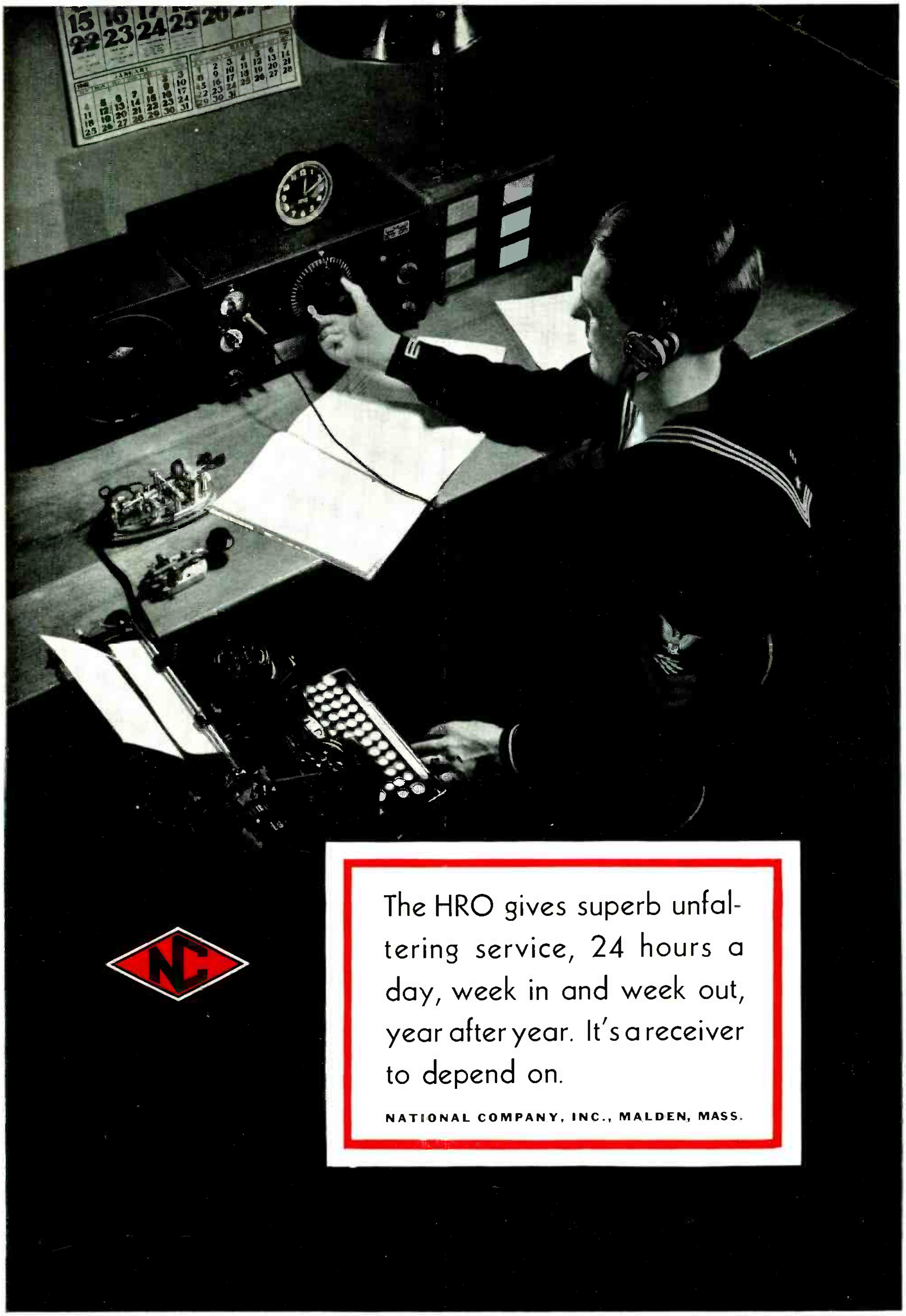
War Department, Federal Communications Commission, Civil Aeronautics Administration, Coast and Geodetic Survey, and other Government agencies are needing radio operators. Persons are needed to stand regular watch for the transmission and reception of radio messages and other communications. In some cases operators will be responsible for the maintenance and operation of a radio station and its equipment. In others they may have to transmit messages by teletype as well as in code.

To fill the jobs, which pay $1,620 and $1,800 a year, an examination was recently announced by the Civil Service Commission. Because of the large number of vacancies which exist applications will be accepted at the Commission's Washington office until further notice.

While no paid experience is required, applicants for these positions must show that they are able to transmit and receive messages by radiotelegraph at a rate of 20 words a minute, transmitting either by hand or bug. For some positions persons are needed who can operate a regular typewriter at 40 words per minute, or a teletypewriter at 35 words per minute. The age limits are 18 to 55. Persons are to be rated on their experience or training and fitness to perform the work.

Operators who are interested in this work and who would be available for Government employment are urged to secure the proper application forms from the Commission's representative at first- or second-class post offices, or direct from the Commission in Washington.

Advertising Index


The HRO gives superb unfaltering service, 24 hours a day, week in and week out, year after year. It's a receiver to depend on.
NATIONAL COMPANY, INC., MALDEN, MASS.